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OBSERVATIONS UPON THE HABITS, STRUCTURE AND DEVELOPMENT OF AMPHIOXUS LANCEOLATUS.

BY HENRY J. RICE.

[*Concluded from the January number.*]

Nervous System.—This system consists of a central and a peripheral portion. The central portion, or *chorda spinalis*, is a long, slender, slightly tapering body, nearly round in section, and extends from the posterior to within a short distance of the anterior extremity of the dorsal aspect of the notochord. The anterior end is somewhat larger, for a short distance, than the rest of the chorda, and forms a sort of elongated head with a short, pointed, beak-like termination, which lies close upon the notochord. Upon the left side of this "head," and near the end or anterior portion, there is a slight cone-like projection, which is in close proximity to and points towards the ciliated pit or depression of the left side of the body. This projection is considered to represent a single olfactory nerve or lobe, and if the pit is indeed a nasal fosse, then undoubtedly this protuberance is an olfactory organ. With the exception of this nerve or lobe this end of the chorda does not present the slightest indication of the divisions or lobes which form the brain of all other vertebrates.

The posterior extremity of the chorda makes a short upward bend, at nearly right angles to its former direction, and expands just above the end of the notochord, into a small, button-like termination, which probably through some accident in finishing the plate, is not shown in the figure of the adult animal. Between the two ends and along the center of the chorda there extends a narrow canal, which is of considerable size in the head portion, where it is enclosed by the anterior walls, but gradually diminishes in calibre towards the posterior extremity, where it is represented by

the merest traces of a cleft or opening, as seen in the center of the "button" of this end.

The sides of this canal, throughout its entire length, are marked by small, black, roundish pigment spots, which are sometimes aggregated into small clusters, but more commonly are scattered along at varying intervals from each other. In the substance of the anterior, beak-like extremity, and just in front of the end of the central canal, there is a large pigment spot which is generally thought to represent the rudiments of a median eye; but if it does not, then Amphioxus is entirely lacking in such an organ. Prof. Quatrefages, in 1845,[1] described and figured a prominent protuberance as existing upon the side of the cord at this end, and claimed that it showed at its extremity a distinct and rather well-developed crystalline lens, thus representing a stalked eye, with the stalk pointing towards the anterior extremity of the body; but later observers have failed to confirm his observations in this respect, the only short protuberance which is formed along this portion being considered as representing, as already mentioned, an olfactory rather than an optic organ.

The peripheral portion of the nervous system consists of a succession of pairs of nerves given off from the upper part of the sides of the chorda dorsalis along its entire length. They originate in single roots, and arise at intervals corresponding to the divisions between each two of the muscle plates. With the exception of the first and last pairs, all the nerves are of nearly uniform size, and, with the same exceptions, they pass outward and downward branching two or three times in their course, to be distributed along the middle and lower portions of the sides of the body. Besides the lower branches, each of these nerves sends off, at a short distance from its origin, a branch which proceeds upwards to the dorsum of the animal, Fig. 6, Pl. 11. The nerves, which form the first pair, arise anterior to the body muscles and from the anterior portion of the head of the chorda. They are quite large at their bases, and extend straight forward from the sides of the chorda towards the anterior end of the body, dividing in their course into a large number of branches which are distributed above and below, and all about the extremity of the notochord. These branches terminate, or at least many of them do, in the cells of the exoderm, or else in small bell-like knobs which are wedged in among the exodermic cells, and resemble them very

[1] Annales des Sciences Naturelles. 3me série, Zoologie. Tome 4me, pp. 197–248, pls. 10–13, 8vo Paris, 1845.

much in shape and appearance. The last pair of nerves which arise at some distance from the end of the chorda, are directed backwards and perform the same offices for the posterior end of the notochord and the tail, that the first pair do for the opposite extremity, but the nerves themselves are not so large, being slightly larger than the ordinary body nerves, and they do not divide into nearly as many branches.

Muscular System.—The muscular system may be considered as made up of two sets of body muscles; two sets of transverse abdominal muscles; few or many longitudinal fibres in and along the abdominal walls; mouth muscles; pharyngeal ring muscles, and sphincters for the mouth, branchiopore and perhaps for the ring or neck of the pharynx.

The *body muscles* are disposed as in ordinary fishes, one set upon either side and each set is composed of a series of regular, overlapping muscle plates, which extend from near the anterior extremity of the chorda dorsalis to within a short distance of its posterior termination. Along the entire length of their dorsal half, the two sets are either united or very closely approximated, and enclose the greater portion of the entire length of the chorda and of the notochord, but leave the extremities of both entirely bare of muscular covering (Fig. 1, Pl. 1). These muscles are also united along the ventral edge of the tail portion, but for the anterior two-thirds or more of their length their ventral edges are quite widely separated, spreading outward and downward from the notochord to form the upper portion of the parietes of the abdomen. The general outline of these combined plates, when seen from the side, is that of a long, slender spindle, gradually tapering from the center to a sharply pointed termination at either end. Each plate is composed of longitudinal, striped, muscular fibres, and is four-sided in outline, but with the greater diameter changing in direction according to the position of the individual plate along the side of the body. Those plates which are near either end are nearly rhomboidal in outline, long and narrow, and with the longer points coincident in direction with the notochord. Nearer the center of the body the plates are almost square, the diameters being nearly equal; while along the middle third, where they become once more rhomboidal, or nearly so, the longer diameter is at right angles to the notochord, with the longer portion of each plate running down into the abdominal walls. On account of the overlapping of each plate by the one immediately posterior to it, this four-

sidedness can be seen only in the last plate, which is entirely uncovered. These muscles give to the body whatsoever of color it may possess, and probably also its metallic iridescence, although this latter feature may be due to the striæ and fibres which exist in the integument. These muscles, from their very great extent as compared with the entire body, also give Amphioxus its remarkable power and activity in the sand and water, and from their similarity of arrangement at either extremity, enable, or rather compel it to move with that beautiful, elastic, line-of-beauty motion which is such an interesting feature of its progress. The *transverse muscles* lie in the walls of the abdomen and extend from the ventral edges of the muscle plates of either side to meet and unite in a raphe upon the median ventral line of the branchial sack. These muscles are nearly transparent in structure, and by their action serve to close the sack walls upon or towards the pharynx, as in the expulsion of water from the branchium by the branchiopore, and as is seen in all hardened or preserved specimens. The *longitudinal abdominal muscles*, which are found chiefly in the lower and posterior portion of the abdomen, probably assist in the contraction of the abdominal walls, and also serve to shorten the sack and open the branchiopore. The *mouth muscles*, arranged in the walls of the buccal cavity and attached to the mouth ring and its appendages, serve to open the mouth, and by this operation unclose the overlapping oral tentacles. It has been said that besides these general muscles there are special muscles which serve to move each individual tentacle separate from the entire circlet. I have never seen any evidence of any such muscles, and never, in a single instance any individual motion of the tentacles, and if such muscles exist their action must be very feeble or entirely nugatory. The *muscles* of the *pharyngeal ring* are situated in the posterior portion of the buccal cavity and attached to the borders of the ring so as to bring the tentacles of these parts forward across the mouth of the pharynx. The *sphincter muscles* surround their respective orifices and serve, as in the case of all sphincters, to approximate the edges of these different apertures. There may be a rudimentary sphincter to the anus, but neither in the young nor the adult have I ever observed what may be strictly called a closure of this orifice.

Reproductive Organs.—These organs consist of a number of roundish or oval bodies formed inside the lining membrane of the walls of the branchium and attached to the ventral edges of the

muscle plates in a single row, along either side of the animal. Each body consists of a case or capsule enclosing a central solid portion or matrix, within which are developed the generative products, and each case is placed with the center of its upper border in juxtaposition to the line of overlapping or junction of two of the muscle plates (Fig. 6 *a*, Pl. II). Ordinarily these cases are small and inconspicuous, and lie entirely below the outline of the body muscles, but in the female, towards the breeding season, the ova increase so much in size that the cases become large and noticeable, closely pressed together, and extend for about a quarter or third of their diameter above the edge of the muscles to which they are attached, thus occupying a goodly share of the sides of the branchium. In the female which was in my possession there were twenty-six of these cases upon each side, extending from a little in front of the middle of the pharynx back to very near the branchiopore. In the males there were respectively twenty-three and twenty-five pairs of cases so that it is probable that there is no great difference in the number of pairs of cases in the two sexes. These generative organs are without outlets, the germinal products escaping from them, when fully ripe, by the dehiscence or bursting of the walls of the capsule and the lining membrane of the cavity, and thus get into the branchium from whence they pass into the surrounding water, the spermatozoa to come in contact with and impregnate the ova, and the ova to develop into young animals.

This escape from the body is probably effected during the feeding time of the animals, when there is a current more or less strong passing through the branchium. The exact method by which the ova become impregnated is not known, but it may be supposed that the spermatozoa, after passing from the male, move about in the water until swallowed by a feeding female, when they pass into the branchium with the greater quantity of the water, and so get to the cases containing the ova, penetrate the capsules, or more likely adhere to the exterior until the ova are extruded, and then effect the work of impregnation. Any ova which were in the branchium at the time of the entrance of the spermatozoa, and which had been recently separated from the cases, would of course be very quickly fastened upon and impregnated.[1] Each ovary, if a single case may be considered to represent an ovary, contains from twenty-five to thirty ova, and each ovum is enclosed

[1] It is possible that it may be shown hereafter that the ova are impregnated only after they pass from the female into the surrounding water, there meeting the floating spermatozoa which have been discharged from the male.

in a separate membrane or cell, any one of which may open and discharge its contents without affecting the rest of the case. Under the microscope these cases appear like small bags of marbles or bunches of grapes, except that most of the ova show a lighter, roundish spot near the center, which represents a nucleus, the nucleolus not being visible (Fig. 4, Pl. 11). After escaping from the cases and becoming free in the branchium, the ova in all probability, pass out of the body, by way of the branchiopore, in the water which is being constantly expelled from this orifice during the process of feeding. Up to 1873 this was considered, by careful observers to be the only method by which the ova could possibly escape into the surrounding medium, and Quatrefages says that he saw them, under the microscope, pass from this aperture. But Kowalevsky, in his paper upon the development of Amphioxus,[1] says that *he* saw the eggs issue from the *mouth* of the female in bunches of fifteen or twenty, and hence concludes that they are normally extruded from this opening. This abnormal proceeding on the part of Amphioxus has been questioned by Wm. Müller[2] on the grounds that the branchial slits are too narrow to admit of the passage of the ova in this direction, and Prof. Huxley seems to be of the opinion[3] that if this proceeding took place as described by Kowalevsky, that it was accidental, and due to some of the ova in passing out by the branchiopore getting caught in the openings of the lateral folds, being carried along the hollows of these folds and discharged at their anterior openings into the mouth cavity and thence out of the body. But this would not account for their issuing in bunches of fifteen or twenty, and moreover, as there are no such openings to the metapleura (ante p. 6), the ova could not have passed in this direction. Prof. Ray Lankester[4] sides with Kowalevsky, and says that in all probability the ova *do* pass from the mouth, but if not by the branchial slits, then by certain openings which exist, one upon either side, and connect the branchium with the buccal cavity. This connection has not been noticed by previous observers, although Prof. Lankester thinks that these openings are the ones

[1] Entwicklungsgeschichte des *Amphioxus lanceolatus*. Von Dr. A. Kowalevsky, Mem. de l'Acad. Imp. des Sciences de St. Petersbourg, VII^me^ série. Tome XI, No. 4, p. 1. St. Petersburg, 1867.

[2] Ueber das Urogenital system des Amphioxus, &c. Jenaische Zeitschrift, Vol. IX, p. 94. 1875.

[3] Classification of the Animal Kingdom. Prof. T. H. Huxley. Quar. Jour. Microscop. Sci., Vol. 15, p. 54. 1875.

[4] Loc. cit., p. 263.

figured by Joh. Müller[5] and considered by him to be the anterior openings of the meta-pleura. In the case of the female which was in my possession, the ova were extruded very gradually and for the most part one by one, so that here and there along the row of cases could be seen, one with a single ovum gone, others, nearer the ends, half empty, and still others, near the middle, with their full quota. During this period, which extended over the entire time the animal remained alive, I was not fortunate enough to see any ova leave the body, but from the size of the branchial slits, the position of the generative bodies, and the actions of the cilia, currents and abdominal walls, which I studied with considerable care, I arrived at the conclusion, which is in accordance with the opinions of Wm. Müller, Quatrefages, &c., that, the ova all passed from the body by the branchiopore, and that while not absolutely impossible, it would be an exceedingly exceptional proceeding if any should pass out by way of the mouth. I found that seven ova placed side by side extended over a space just equal in length to the breadth of five branchial slits with their enclosing arches, and as the bars of the arches are quite as broad as the slits, the ova in passing out in this direction would be obliged to pass in opposition to the powerful action of the branchial cilia and inflowing water, through openings which at most would be only seven-elevenths as broad as the diameter of a single ovum, which would be an exceedingly difficult performance. If the openings mentioned by Prof. Lankester exist, and are no broader than the breadth of the branchial slits, there would be the same difficulty in passing through them as in forcing a way through the slits, besides having to traverse nearly half the length of the pharynx against the current of water and the pressure of the abdominal walls. If these openings are larger than the openings of the slits, it would hardly seem possible that they could have remained undetected until this late date, but even in this case the passage of ova through them could hardly be more than an occasional and chance occurrence, since the same obstacles exist to the passage of the ova forward to these openings as in the case of the smaller ones, and are even increased by the liability of currents of water setting through them into the branchium and thus assisting in expelling the ova

[5] Ueber den Bau und die Lebenserscheinungen des *Branchiostoma lubricum*. Von Joh. Müller. Abhandlungen der Berliner Akad. Berlin, 1842 (1844), Pl. III, Fig. 4, *e*.

by the branchiopore. Thus in any case there would be great difficulty for the ova to get *into* the mouth cavity, and when once in they would be fully as liable to be drawn down through the pharynx into the stomach as to be expelled from the body. But it seems to me that it is not necessary to suppose any such difficult and abnormal passage, as it appears possible to harmonize, in a natural manner, the opposing views of Kowalevsky with those of Quatrefages and Wm. Müller, for *apparently* the ova *may* proceed from the mouth, while *actually* they make their exit from the branchiopore. When we consider the position of Amphioxus during feeding time, that is, when it comes to the surface of the sand, we find that it has formed for itself a sort of sand tube in which it lies, belly upwards, with its mouth orifice, or a small portion of its body exposed to view, as it was when Kowalevsky saw the ova issue. Now at every contraction of the abdominal walls there will be left a space between the body and sand, extending from the branchiopore to the mouth, or near it, through which the water expelled from the branchium may pass to and mingle with the water above the sand. And if at this time the ova are extruded from the pore along with the water, they will naturally rise to the surface of the sand, pass along by the mouth tentacles, *appearing* to any but the most careful observation *to come from between them*, and so into the medium where they float about until transformed into young Amphioxi. If this is the true method of procedure, as it is the most simple and natural, it will account, *as no other method will*, for the little bunches of fifteen or twenty which Kowalevsky saw emerge into the water. For in passing from the pore out against the sand it would be very easy for some of the ova to become lodged against the sides of the tube until a number of them accumulating together would form an obstacle of sufficient importance to be forced out by the outflowing water, and sent along by the tentacles, when they would be seen rising in the water as if just escaped from the mouth cavity.

The Urinary System.—The earlier anatomists who examined Amphioxus were unable to discover any organ, or series of organs, which could be considered as acting as specialized excretory vessels for the urinary products, and for quite a time it was a matter of considerable speculation as to the method by which these products, if any were formed, were eliminated from the body. Very soon, however, certain isolated, ductless, glandular patches were

discovered to exist upon the floor of the posterior portion of the branchium near the branchiopore, and as no other function could be thought of as being performed by them, and as there were, apparently, no other organs which might subserve the purposes of excretion, it was supposed that these patches acted in this capacity, and after eliminating the urinary products cast them into the branchium to be extruded from the body through the branchiopore with the water which passed from this orifice.

This opinion, which might be considered as very plausible, since the patches were associated in position with the posterior generative bodies, was very generally held until quite recently, but in the paper by Prof. Lankester, already referred to, he announces the discovery of certain canals which he considers as representing, rather than these patches, the true urinary ducts of Amphioxus. These vessels, one upon either side, are in the form of long tubular ridges, formed along the roof of the pleuro-peritoneal portion of the branchium as outgrowths from the mesoderm of the body walls. They are composed of pigmented cells and their posterior extremities are open and communicate with the branchium near the branchiopore, but their anterior extremities, which are in the neighborhood of the sides of the pharynx, are probably closed. These canals are thus apparently homologous with the earlier stages at least of the ducts of the uriniferous tubules of other vertebrates, and unless further investigation shows them to appertain unmistakably to some other system they will undoubtedly henceforth be considered as representing, as Prof. Lankester suggests, the urinary system of this animal.

The Blood Vessels.—The general arrangement of the vessels of the blood system in Amphioxus is very similar to that found in the young of all osseous fishes, but in the minutiæ of the plan there are quite important modifications, which, although not making a complicated system, yet render it very different from any other known among vertebrates. The main blood vessel, or vein, extends from the anus along the ventral aspect of the intestine to the base of the saccular liver, thence around the entire length of this organ upon both ventral and dorsal edges, to continue along the ventral aspect of the œsophagus and pharynx to a point just beneath the first branchial cleft where it expands or merges into a bulbous organ, the heart. This canal is pulsatile, and has been given different names according to the section of

the body through which it passes, but it is undoubtedly to be considered as a single vessel, since it is of nearly uniform calibre throughout its course, and the rythmical contractions, which are a very marked feature and readily seen, especially in the young, pass from behind forwards, at somewhat lengthy intervals, along its entire length. Up to quite recently this long tubular vena cava was considered to be the sole pulsatile organ of Amphioxus, and as a "tubular heart," which was the term applied to it, was an anomaly among vertebrates, it was thought fit to designate the "thin" from the "thick" hearted vertebrata, and thus separate Amphioxus from the rest of the family by instituting for its sole reception the class Leptocardia. But in 1876 Langerhans announced[1] the discovery of the organ, which is described above, as being situated at the anterior extremity of the vena cava, and which he considers as representing the heart. If this is the case, and Amphioxus does indeed possess a thick-walled pulsatile cavity, the above classification may have to be revised, but even then the pulsatile character of the vena cava, together with the other peculiarities in the organization of Amphioxus, may be considered of sufficient importance to make it the unique representative of a distinct class. From each side of the pharyngeal portion of the vena cava a series of vessels are given off, which correspond in number and position to the main bars of the branchial arches, and through which these vessels pass to the dorsal edge of the pharynx, where they unite into two aortæ, which run back without any intercommunication, one upon either side of the median line, to the œsophagus, where they unite into a single tube, which proceeds as a distributing vessel to the end of the body. Each series of these branchial or blood-renovating vessels forms its own aorta, and each individual vessel has, at its base or origin, a small dilatation or bulb-like enlargement to which the name of "branchial heart" has been given. These "hearts" lie in the alternating triangular spaces between the curved bases of the cartilaginous arches, *a*, Fig. 4, Pl. 1, and probably act as elastic reservoirs to render the flow of blood steady and continuous through the branchiæ. The main heart, into which a certain, perhaps a large proportion of blood from the vena cava passes, gives off three vessels, two small ones from its anterior border,

[1] Zur Anatomie des *Amphioxus lanceolatus*. Von Dr. Paul Langerhans. Archiv für Mikrokopische Anatomie. Band 12, p. 336, fig. 49*c*. Bonn, 1876.

and a large one from its left side. The anterior vessels proceed to and supply the walls of the buccal cavity and the tentacles, and the left branch, which forms the ductus Botalli, or aortic arc, passes across the pharynx between the pharyngeal ring and the anterior branchial clefts, to unite with the left aorta, formed by the union of the left branchial vessels, and by this route sends its blood into the main arterial channel.

The blood of Amphioxus is colorless, containing only white nucleated corpuscles,[1] and very few of these. The manner, however, of its distribution from the aorta and branches of the heart to the different parts of the body and its return to the vena cava and heart is not at present known. It may be that the passage is effected by means of capillary vessels which are so minute that they have not as yet been made out, or it may be, and which is much more probable, that this fluid passes through the interspaces between the various tissues, or in other words, that the large blood vessels terminate as blood sinuses.

Development.—For those changes which take place in the embryo of Amphioxus previous to the formation of the side folds, and for most of my information in regard to the growth of these folds, I am chiefly indebted to the investigations of Kowalevsky[2] who has shown that shortly after the impregnated ovum leaves the branchium of the female and passes into the surrounding water, the granular vitellus, which nearly fills the rather delicate vitelline membrane, undergoes complete segmentation and gradually builds up a thin-walled, nearly spherical morula, which soon, under the energetic action of the numerous external vibratile cilia, each cell of the wall being furnished with one or more of these little lashes, begins rolling over and over, quite slowly, within the enclosing membrane, agreeing in this respect with what is seen in the ova of certain other vertebrates and many of the invertebrata. After the commencement of these rotary movements, or it may be before they begin, the morula becomes transformed, by the introversion of one side and the subsequent near approximation of the edges of the cup thus produced, into a gastrula, and the gastrula, by the elongation of its

[1] Examination of the corpuscles of the blood of *Amphioxus lanceolatus*. Prof. T. H. Huxley. Report of Brit. Ass. of Science. London, 1847. Report of sections. p. 95.

[2] Loc. cit. and Weitere Studien über die entwickelungsgeschichte des *Amphioxus lanceolatus*. Archiv. für Mik. Anatomie, XIII, p. 181. Bonn, 1877.

sides in the direction of the axis which passes through the gastrula mouth, or blastopore, changes into a slender, compressed, double-walled, planula-like body, ciliated within and without, and with the two walls, or exoderm and endoderm layers, which surround the rather large central cavity of invagination, lying close together one within the other, but separated by a narrow space which represents the remains of the original segmentation cavity of the morula. By the time the embryo is well established in its planula form, the blastopore, which marks the posterior extremity of the body, closes up entirely, or at least it is highly probable that it does, and the young Amphioxus escapes from its shell and becomes a free swimming inhabitant of the water. The cells of the exoderm and endoderm, along one edge of the embryo, now become longer and larger, entirely obliterating in their growth the segmentation cavity in this part of the body, and form between them, throughout the length of the animal, a strip of mesoderm in the center of which arises the notochord and from the sides of which originate the muscle plates of the body muscles. As the mesoderm thickens, two longitudinal ridges grow up from the exoderm and, arching over, unite upon the median line into a dorsal tube which runs parallel with and close above the notochord. Within this tube the central portion of the nervous system is formed. This arises as a second tube lining the walls of the first, and originates from the differentiation of the exoderm cells of the latter. During its formation the ends of the dorsal canal have been gradually closing up, one of them, the posterior, completely, and the other, the anterior, all except a narrow outlet which persists until a somewhat later stage of development.

Meanwhile the whole body lengthens; the exoderm of the ends stretches away from the endoderm into thin blade-like points; the central cavity, limited by the transformation of the dorsum to the lower half of the body, becomes long and tube-like posteriorly, and quite broad throughout its anterior third; a welt or pear-shaped body, with the narrow end pointing downwards, forms across the anterior end of this broad pharyngeal portion of the central cavity, and the external cilia, which heretofore have been the sole motive power, supplanted in their functions by the muscular fibres of the mesoderm, disappear, except upon a small depressed pit-like bit of surface situated upon the

left side of the anterior end, a short distance back from the extreme point of the body. The middle part of the tubular portion of the central cavity now enlarges into a small oblong stomach, with obliquely-placed cilia along its walls, and openings, formed by ingrowths of cells from the exoderm, appear upon the left side of the body, one at either end, placing the central cavity in communication with the exterior. The posterior of these openings is formed at the very extremity of the cavity, at the base of the exodermic tail expansion, and at or near the point of closure of the blastopore, and it may be that it is rather a reopening of the old gastrula mouth than a new formation, although the latter seems to be the opinion at present.[1] It is small, slightly dilatable, and becomes the anal aperture of the intestine. The anterior opening penetrates the body wall along the anterior half of the pharyngeal portion of the cavity and becomes the mouth orifice. It is at first a short longitudinal slit, but soon broadens into an oval aperture of considerable size, with long, slender, alternating, teeth-like processes extending out from the edges towards the center as guards to the entrance, and a thickening of the body wall takes place just below it, forming a prominent ridge-like border extending from near the median line below the cartilaginous, pear-shaped welt, backwards and upwards to very nearly the level of the notochord. Along the inner, lower edge of this mouth-ridge there are generally two or three slender pointed processes which lie close to the body and point towards the right side. The central cavity is thus at once transformed into a digestive tract, the food particles being drawn in at the mouth by the action of the internal cilia, passed on to the stomach, where they are twisted and ground up for the nutrition of the animal, and the refuse material sent onward to the anus and so out of the body.

A third opening now makes its appearance, piercing the body wall upon the median ventral line just below the mouth orifice. It is somewhat larger than the anal opening, longer than broad, with the longer diameter transverse to the length of the body, and forms the first of a series of ten or eleven similar pharyngeal clefts which open along the under side of the pharynx at regular distances back to very near the middle of the body. Coincident with the formation of this first pharyngeal cleft, two delicate

[1] Early stages in the development of Vertebrates. F. M. Balfour. Quar. Jour. Mic. Science. Vol. XV, p. 208. Camb., 1875.

longitudinal folds arise from the exoderm along either side of the entire length of the upper portion of the central cavity, and grow outward and downward toward the ventral aspect of the body. They soon attain a level with the lower edge of the intestine, which, as already mentioned, is much narrower than the pharyngeal section, and those portions of the folds which lie along the intestine closely embrace it as a sort of tubular outer coating, and unite along their edges into a broad median ridge which extends from the anus, where it merges into the exodermic tail expansion, to a point just in front of the stomachic dilatation. This ridge forms the ventral extension of the continuous ventro-dorsal median fin.

The anterior portions of the folds now increase in breadth, leaving quite a space, the rudiments of the branchium, between their edges and the alimentary tract, and gradually unite but with a smooth, unridged surface, along the median line forward toward their anterior extremities. In this union an opening is left between the edges of the folds just at the point where they leave the anterior edge of the coalesced ventral ridge; this opening, which forms a means of communication between the cavity enclosed by the folds and the exterior, represents the abdominal pore, or branchiopore. It will thus be seen that the abdominal portion of the animal presents two widely different sections; the one, posterior, with firm walls, closely surrounding the intestine and stomach, and with a very restricted cavity enclosed between the body walls and this portion of the digestive apparatus; and the other, anterior, with thin dilatable walls, which are at some distance from the alimentary tract and which enclose quite an extensive cavity or space, which communicates directly with the exterior and with the cavity of the posterior section. It may be that these two sections are somewhat more complicated in their formation than I have indicated above, that while the posterior portion is fashioned as already mentioned, the walls of the anterior cavity are formed by the outgrowth of new folds from the inner edges of the old ones; that is, that after the coalescence of the posterior portions of the first folds around the intestine, these folds grow no further, but a new set originate from the inner anterior borders of the first, and by the extension and subsequent union of these more delicate laminæ, the walls of the anterior cavity are formed. The peculiar pit-like character of the bran-

chioporic depression would seem to indicate some such development, and in this case the lateral abdominal folds, the metapleura of the adult, would represent the external edges of the first pair of reduplications. This point will, however, be rather difficult to ascertain, and I am obliged to say that in none of my young specimens did I see any direct evidence of any such secondary growths, the development appearing to be as first described, so that I shall continue to consider the cavities as formed only of two folds. In whichever manner, however, they are formed, the one slender and of little account, being barely discernible, the other large and of great importance in the animal's economy, they are both lined, from the nature of their formation, with a continuous layer of exoderm, that upon the external walls of the cavities being derived by cell multiplication directly from that which covers the inner walls. At this period the right fold extends forward as far as the edge of the cartilaginous welt, where it merges into the exoderm, the left, as yet, only to and uniting with the edge of the mouth ridge, both being perfectly free from the sides or lower edge of the pharynx, and by the time they have united along their ventral edges to a short distance in front of the branchiopore, two or three additional pharyngeal clefts have formed along the median line of the pharynx, and the animal now appears much as shown in Fig. 7, Pl. II, which represents the youngest of the specimens which came into my possession. Here can be seen the long notochord with the slender, tubular, spinal axis above it; the ciliated pit just in front of the pear-shaped welt; the side mouth with its teeth or tentacles; the cilia lining the alimentary tract; the long œsophagus, the dilatation for the stomach and the asymetrical anus forced to one side by the outgrowth of the exoderm of the tail and the median ridge of the ventral folds; the depression indicating the position of the branchiopore; the three pharyngeal clefts piercing the pharynx beneath the mouth aperture, and the long tubular heart, formed at about this period, between the endoderm and exoderm of the ventral edge of the alimentary tract. The shape of the animal is quite characteristic, very much compressed from side to side and pointed at either extremity, but the posterior end is not often knobbed, as shown in the plate, having generally the shape shown in Fig. 5, Pl. I. The full number of clefts now soon appear along the lower edge of the pharynx between the open edges of the side

folds, and, about the time of the formation of the last cleft, the mouth aperture begins to change its position, moving forward very slowly toward the cartilaginous welt and the ciliated pit. Accompanying this forward movement of the mouth the anterior pharyngeal clefts become pushed over toward the right side of the pharynx, and to a slight extent under the right fold; the posterior part of the ciliated pit grows backward, burrowing into the tissue toward the cartilaginous welt; and the cartilaginous welt broadens throughout its upper portion, the upper posterior limb growing backward towards the mouth, and a slit or opening forms through its center so as to transform it into an irregular pear-shaped ring of cartilage placed obliquely across the anterior portion of the central cavity. Fig. 5, Pl. II, represents a diagrammatic cross-section of the body at this stage of growth. The section is made transversely through the mouth and one of the pharyngeal clefts, as at *a*, Fig. 7, Pl. II. The mouth opening, with its teeth-like processes, is seen upon the right side; the mouth *welt* with *its* processes below it; the pharyngeal cleft pushed just to the left of the median ventral line; and still further to the left a slight indication of the anterior portion of the right body fold. The mouth and pharyngeal apertures open directly into the digestive tract.

The forward movement of the mouth, and the backward movement of the ciliated pit, continue until the anterior edge of the mouth aperture is close to the posterior limb of the cartilaginous ring, and the posterior portion of the ciliated pit has burrowed back to the opening in the ring, when a split takes place in the body wall extending from the mouth opening forward over the the edge of the cartilaginous welt and through into the ciliated pit, Fig. 2, Pl. II, in which only the edge of the ciliated pit is indicated, the central, deeper portion being back towards the central dotted lines of the figure. This split now deepens or extends to the center of the pit, forming a passage-way into the digestive tract through the cartilaginous ring; the mouth aperture and split in the body wall gradually close; the bottom of the ciliated pit becomes attached to the edge of the cartilaginous ring, which is already attached to the walls of the anterior extremity of the pharynx, and the food passes into the digestive tract from this time forward by way of the newly opened aperture in the bottom of the ciliated pit. This is a marked advance in development,

and it is hardly more than accomplished, and perhaps in many instances not completed, before the body folds close up entirely over the pharyngeal clefts, the left body-fold advancing towards the cartilaginous ring coincident with the advance and final disappearance of the pharyngeal mouth aperture and mouth welt; the first two or three pharyngeal clefts become pushed almost entirely over upon the right side of the pharynx; the ciliated mouth cavity enlarges anteriorly, the dorsal and posterior edges growing downward and forward, and small fleshy prolongations appear upon the posterior edge; and two or three small oval openings appear piercing the left side of the pharynx at points intermediate to the already formed pharyngeal openings, in a line just posterior to the cartilaginous ring and beneath the level of the notochord. Fig. 1, Pl. II, shows the appearance of the anterior portion of the animal at this time, with mouth tentacles beginning to show along the posterior edge of the cavity, and the oblong openings along the left side of the pharynx.

These openings in the pharynx represent the rudiments of the left branchial fissures or arches. They increase in size until the first one is about one-half the width of the pharynx, when a small protuberance forms in the center of the upper or dorsal border, and grows downward towards the ventral edge, finally merging with it and dividing the opening into two more or less elongated apertures, the branchial slits or clefts. Before this division is effected however, each of the other openings has given rise to a central prolongation, which grows downward to finally unite with the lower border, as in the first case, and two or three new openings have pierced the pharynx, one between the first arch and the cartilaginous ring, and the other in a line with, and posterior to, those first formed in the pharyngeal wall.

Of these new arches, the first one never becomes divided by a central bar, but each of the others is divided in turn into two sections, as a new opening makes its appearance in the pharyngeal walls. As there appears to be no limit to this formation of arches, and of their division into clefts, in the growth of the individual, there is always to be seen in either young or adult, a posterior round or oval aperture and just anterior to it one or more openings partially segmented by central prolongations, although sometimes the last aperture indicates the central division, by a curvature of the dorsal edge, before the new opening is formed. After

the segmentation of the arches, each bar becomes itself divided, in time, into two halves, or at least marked, as seen in the adult, by a distinct central line of division, Fig. 4, Pl. 1. In all of the arches a circlet of long cilia appear around the inner edge as soon as the aperture is formed, and, with the growth of the central bars, the circlet gradually extends so as in the adult to nearly if not quite curtain each cleft, and when in motion form such admirable strainers for these openings, as has been indicated when speaking of the habits of these animals. The movement of the cilia is wave-like and continuous around the edge of the slit, with the *stress* or *emphasis* of the motion always in the same direction.

In the meantime, while the left branchial arches have been enlarging and dividing, the first three or four pharyngeal openings have attained a counterbalancing position upon the right side, and have, similar to those of the left side, become divided into branchial slits by the downward growth of central bars, and the remaining pharyngeal openings have entirely disappeared, so that at this period both sides are pierced by ten to twelve similar alternating clefts, the first one of the right side being formed like the corresponding one of the left side, after one or two of the old apertures have become divided into clefts, although it is possible that in some instances this first slit may be the first pharyngeal opening, which has remained small and undivided, merely increasing slightly in length in the direction of the breadth of the pharynx, with the general increase in length of the other clefts. The subsequent arches of the right side are of similar formation to those of the left, that is, they are new openings, which are formed through the wall of the pharynx, and in all probability none of them have any relation to the five or six pharyngeal openings which closed up during the changes of the first three or four. Accompanying these modificatiens which take place in the arches, there is an enlargement of the ventral portion of the center of the alimentary tract, and a forward movement of the stomach, so that this organ comes finally to lie within the enlarged anterior cavity of the abdomen, rather than within that portion closely embraced by the side walls.

The enlargement of the alimentary tract is, at first, in the form of a mere swelling-out of one side, accompanied by a pigmentation of the cells of the walls of this section of the tract, but, in a short time a diverticulum, with greenish walls is formed, which

grows forward (Fig. 3, Pl. II), gradually pushes its way along the side of the pharynx (Fig. 3, Pl. I), and becomes the asymetrical liver of the adult.

As the liver passes forward around and along one side of the pharynx, that portion of the ventral tubular vessel of the blood system which passed beneath it becomes stretched out into a peripheral ventral and dorsal vessel for this organ, so that there is, so far as can be made out, no connection between the intestinal and pharyngeal portions of the ventral vessel, except by way of this extension which outlines the liver. In Fig. 5, Pl. I, the liver enlargement is represented at about the time it begins to form, and the ventral vessel is seen to conform to the outline of its lower edge.

A second vessel is also represented, which first appears about this time, extending from the cartilaginous base of the pharynx, between the branchial arches and the pharyngeal ring, upwards and backwards to the ventral aspect of the notochord, where it becomes lost to view. This vessel is the aortic arc or ductus Botalli, and with the exception of this arc and the ventral vessel, with its hepatic continuation and the swellings at the bases of the branchial arches, no portion of the blood system can be made out in the living, young or adult animal. At this period the branchial arches are seven in number upon either side of the pharynx, the third and fourth from the anterior end being largest, and are very broad and well defined, with very large spaces between their broadly pointed bases, and the stomach is seen just over the branchioporic depression, and extends forward into the enlargement caused by the swelling-out of the alimentary tract for the liver cæcum, and in fact this enlargement, and also this section of the alimentary tract after the farther growth of the liver, seems to form a very important part of the stomach, and the swaying, twisting mass of food, with the accompanying oblique arrangement of the cilia, generally extends from the posterior limits of the œsophagus to the beginning of the intestine. The advanced state of the mouth cavity and the tentacles upon the pharyngeal ring will also be noticed in this figure. From the condition as shown in Fig, 1, Pl. II, the posterio-dorsal, or left, and the ventral, or right edges of the mouth cavity gradually work downward and forward until the ventral edge nearly coincides with the ventral edges of the anterior portion of the body, by which time this

edge has become lip-like and three or four finger-like prolongations have formed from the exoderm of the lip.

At the same time with the forward growth of the left side wall, the tentacles of the left side have grown longer, increased in number by the addition of one or two prolongations from that portion of the wall of the cavity anterior to those tentacles already formed, and become strengthened by cartilaginous supports formed in the tissue of each tentacle, as tentacular segments, already noticed in the adult, of the left branch of a ring which develops around the edge of the mouth aperture from the base of the cartilaginous ring of the pharynx.

At this period the mouth tentacles have very little share in guarding the mouth cavity from the entrance of large or injurious particles, this duty being delegated almost entirely to the tentacles of the pharyngeal ring, which were formed very soon after the opening of the passage-way through the bottom of the ciliated pit into the pharynx. And while these pharyngeal tentacles are thus of much greater importance to the young than to the adult animal, they are always of service, as has been noticed upon a previous page, in ejecting large bodies which may have succeeded in passing the network formed by the mouth circlet and getting into the mouth cavity. The further development of the mouth cavity is comparatively simple; the left side continues its downward and forward growth, until it is upon a level with the right edge, and the mouth opening becomes a median, ventral aperture just posterior to, and guarded by the rather blunt proboscis of the animal; the right branch of the mouth ring with *its* segments, forms in and along the edge of the right wall, and the cartilaginous supports grow out into the right tentacles; the remaining tentacles, to the number of ten or eleven on either side, making about thirty-one in all, gradually form along the sides, arching inward and forward, so that those of one side overlap and interlace with those of the other, and the mouth cavity assumes its normal adult appearance (Fig. 1, Pl. 1).

By following carefully the development of the mouth cavity of Amphioxus, as I have sketched it in the previous pages, it will be seen to be a true, although somewhat irregular, introversion or inward growth of the exodermic tissue to meet the endoderm of the central canal, and hence is homologous in character with the mouth cavity of the higher vertebrates. It has heretofore

been generally considered that the mouth cavity of Amphioxus was formed by the anterior portions of the side folds overlapping and finally enclosing the anterior end of the pharynx, and by this method of development making the mouth cavity an anterior portion of the cavity surrounding the pharynx. But in none of my specimens could any evidences of any such method of formation be seen, and there are, moreover, certain facts in connection with the formation of the mouth cavity which would seem of themselves to corroborate, to a certain extent at least, my view of the development. First, the mouth being formed upon the left side of the body, has, in the anterior exodermic expansion, a previously-formed right wall, and any extension of the right fold over this portion of the body would only form a third layer over the side and not be of any value in the formation of the cavity, or connect it in any manner with the cavity surrounding the pharynx. Second, the left fold, in order to form the left side of the cavity would have to pass forward over the pharyngeal mouth aperture, and in so doing would so affect the inward flow of food material that this forward growth could be easily observed, provided any such forward growth took place. But the left fold is always limited anteriorly, so far as I have observed, by the mouth welt, and advances towards the cartilaginous ring only as the mouth welt advances towards the edge of the ciliated pit, hence my investigations have led me to the conclusion already mentioned, that the mouth cavity is formed by a true introversion of the exoderm, and is genetically distinct from the branchial cavity. For this reason, combined with the fact that the branchial cavity is essentially branchial in its function, and quite different in its formation from the atrium of some at least[1] of the Tunicates, its walls having more of the nature, in their development, of the gill covers or opercula of osseous fishes,[2] and because it does not

[1] The Anatomy of Invertebrated Animals. By T. H. Huxley. London, 1877, p. 609.

[2] To indicate my meaning as to the homology of the branchium, I would say that if those portions of the side folds, which by their union form the median ventral fin, should be extended forward to a point along the œsophagus, and by their union or coalescense at this point completely cut off the posterior from the anterior cavity; and the ducts of the uriniferous ridges should extend back to the anus, where they could open into a cloaca, and the generative products instead of bursting through the lining of the walls into the branchium, be carried back between the lining and the muscles to the cloaca and there discharged, or in other words, if the pleuro-peritoneal cavities of the roof of the branchium should become more enlarged in the pos-

function as a cloacal chamber, although indeed receiving the urinary and generative products, I have thought it best to give it the name of branchium rather than that of atrium, which is applied to the branchio-cloacal chamber of Tunicates.

The changes which take place in the nervous system while these transformations are taking place in the muscular system and integument, appertain chiefly to the growth and extension of the nerves out into the parts of the body from the chorda spinalis. The chorda itself changes very little in the growth of the animal from what it was in the embryo; the principal difference being that in the adult the central canal has become almost completely filled up, except in the "head," by the thickening of the walls, and the pigment spots are perhaps somewhat larger and more numerous. The posterior extremity is turned up very slightly from a very early period, but it does not exhibit the button-like termination until later in life. The anterior end, or "head," enlarges somewhat in the growth of the animal, so as to represent a very rudimentary brain, and the beak of the "head" and the olfactory nerve attain their adult characteristics probably coincidentally with the outward extension of the peripheral portion of the nervous system, or the general body nerves.

The farther development of Amphioxus has already been indicated in the forward growth of the liver, the multiplication and elongation of the branchial slits, the outgrowth of the ventral cartilaginous processes, forming a base to the ventral median fin, and the extension of the muscle plates down into the body walls.

With these transformations are associated certain changes in external form, particularly in regard to the shape of the two extremities and the appearance of the metapleura of the side folds, and when these are accomplished, the animal has assumed its adult form, as represented in Fig. 1, Pl. 1, and with the development of the generative bodies along the edges of the muscle plates, becomes capable of reproducing its kind.

In conclusion, it may not be unprofitable to summarize, somewhat hastily, those particular features in which Amphioxus dif-

terior portion of the animal, and while extending to the cloaca and opening there, include in their cavities the reproductive organs, then this posterior cavity would represent a true perivisceral cavity or chizocœle. In this case the anterior portion of the folds, forming after the posterior portions, and either from them or in front of them, would be true opercula covering the branchiæ, and it is possible that the growth or formation of the body cavity and opercula in vertebrates has been along some such line of development.

fers from other vertebrates. Beginning with the external characteristics we find a median ventral fin, which is continuous with a long median caudo-dorsal fin, extends for some distance in front of the anal aperture, and which extends quite to the anterior extremity of the body; an anal aperture placed upon the left side of the median line of the body and opening about midway of the side; an abdominal aperture or branchiopore; a longitudinal mouth opening; a circlet of mouth tentacles; and a single asymmetrical nasal pouch. It is very questionable whether the anterior pigment-spot of the spinal cord is of any more value than any of the other pigment spots of the nervous system, hence Amphioxus may be said to absolutely lack both eyes and ears.

Internally we find a saccular liver; and an alimentary tract lined with vibratile cilia. The notochord, besides lacking any anterior cranial expansion, may differ in its structure and mode of development from the notochord of higher vertebrates, but this question is as yet undecided. The remaining organs represent rather embryonic forms of the same organs in higher animals, than different features; thus the spinal cord, with its slight anterior enlargement seems to represent that stage of the central nervous system of higher vertebrates just before the cerebral vesicles are formed; and the blood system, if, as Langerhans claims, there is a heart, and if the blood is distributed throughout the body and returned to the ventral tubular vessel through the spaces in the tissues, rather than through capillary vessels, would be, excepting the position of the heart and the pulsatile character of the vena cava, simply what is seen in all young vertebrates, or at least as seen in the young of osseous fishes, where the course of the blood in the smaller channels is continually changing from one interspace to another, whenever, from any cause, any one channel becomes stopped up, and these changes continue until the capillary vessels are formed. Amphioxus is thus seen to be a *very* peculiar animal, presenting some resemblance to the Tunicates in the ciliated pharynx and pharyngeal tentacles, yet evidently more closely affiliated as an embryonic form, with the great vertebrate branch of the animal kingdom, than with any of the Invertebrata.

A SKETCH OF COMPARATIVE EMBRYOLOGY.

I.—THE HISTORY OF THE GENOBLASTS, AND THE THEORY OF SEX.

BY CHARLES SEDGWICK MINOT.

THE series of articles, of which this is the first, is intended to present in a simple and popular manner, the leading results of the very numerous researches upon the development of animals, published during the last fifteen years. These researches have completely altered the whole science of comparative anatomy and animal morphology, by entirely upsetting a large part of Cuvier's classification and the idea of types upon which it was based, substituting the demonstration of the fundamental identity of plan and structure throughout the animal kingdom from the sponges to man. The details of the observations are already too many for any but the most industrious specialist to become familiar with. We have now entered upon the period of generalizations, which are already so numerous and important that it is impossible to study scientific zoölogy without some knowledge of them. This great progress is still so recent that its results have not been transferred to the text-books, nor even gathered together in any scientific review. Nevertheless, it is possible to compile an outline which may be accepted as fairly correct. This outline it is my present object to trace, with the hope that it may prove at once accurate and useful.

Each branch of the subject will be treated by itself. The illustrations will be taken mainly, if not exclusively, from pen drawings prepared by myself for a work on Comparative Histology, upon which I am engaged. The original source of each figure will be given.

The arrangement of topics will be, first the structure of the egg and spermatozoön; second, the phenomena of impregnation; third, segmentation and the formation of the germ-layers; fourth, the essential features of the embryology of the leading animal types, beginning with the simplest and ascending to the most complicated and highest.

The starting point of comparative embryology, as indeed of nearly all branches of biology, is the cell, composed of the nucleus surrounded by protoplasm. A few years ago the theory was advanced that the nucleus was unnecessary, and various observations were adduced to show that in a considerable number of

living objects there was nothing but protoplasm. In accordance with this view this substance was called the "Physical Basis of Life," under which name it has been much paraded before the public. By a great many persons protoplasm is conceived and described as a "simple mass of jelly." By an easy illogic this phrase of the very ignorant becomes a demonstration that life is a mere property of matter—but that is no matter to us now. What does concern us, is that protoplasm is not a mere simple mass of jelly, but is certainly very complicated, perhaps so complicated that its constitution is beyond the power of human conception. One of the visible indications of the complexity of protoplasm, is, that it is not a continuous substance, but interrupted by vacuoles or cavities, which vary in size, shape and number. These cavities are usually round or oval. The protoplasmatic partitions between them form a complicated network. Sometimes the cavities may fuse together, by a breaking through of the partitions, in which case the network is reduced to a number of connecting threads. The cavities are not empty, but filled with various substances, sometimes liquid, sometimes solid, and differing in chemical composition, as the protoplasm is from one kind of cell or another. For the contents of the vacuoles I propose the name *enclosures*. It will be seen that protoplasm forms only the network which surrounds the other substances. This is an important fact, without knowing which, it is impossible to understand the formation of eggs.

Let us return to the nucleus. It has been asserted that there are numerous animals (*Monera*, etc.) mostly microscopic, which consist solely of protoplasm without any nucleus, and also in some cases that the egg-cell ejects its nucleus, and then it is called a *cytode*. Now it has been shown that a very large proportion of these unnucleated protoplasms (*Protista*) really have a nucleus, and are unicellular animals or plants; therefore it is *probable* that no protoplasm can live without a nucleus, that is to say without being part of a cell.[1] So also with the egg; it has become probable that it never loses its nucleus.

The result of these discoveries is to reëstablish the full importance of the *cell*, as the unit of animal and vegetable organization. Recent investigations by Bütschli (No. 18) and Engelmann upon

[1] The reader must remember, however, that a number of minute organisms exist in which no nucleus has been observed. Future research will decide whether the absence of the nucleus is real or apparent.

the Infusoria have strengthened the movement of return towards the earlier doctrine, which had been for a while crowded aside by the over-hasty advocacy of the protoplasm theory. Bütschli especially has made it extremely probable that all Infusoria are but highly specialized and curiously modified unicellular beings.

It is certainly safe to assume for the present that no life can exist outside of cells, and that all the phenomena of development must be reduced to terms of cell-life. The first point, therefore, to be settled is the relation of the sexual products to the cells from which they are derived, and the multiplication of which they effect. I shall give an hypothesis of these relations, which I have formed, and which is the only one, so far as I am aware, yet proposed. Whether this hypothesis will ultimately prove correct or not, it is impossible to foresee. As it still appears to me plausible, I shall venture to reproduce it here. To explain it, it is necessary to premise brief accounts of the structure of the sexual products (genoblasts) and their development. We will begin with the egg.

The essential part of every egg is developed from a single cell, which undergoes certain modifications, probably nearly the same in all animals, thereby acquiring the definite characteristics which distinguish it as an *egg-cell* from an ordinary cell, and from all other specialized forms of cells.

The eggs of different classes and even species of animals are, as is well known, extremely unlike in appearance. The dissimilarity refers chiefly to size, and to the nature and number of membranes or envelopes by which the egg-cell proper is surrounded by the parent. Thus in the hen's egg, the yolk alone represents the part formed by the egg cell, while the white of the egg and the egg-shell are only secondary envelopes, the former serving to nourish, the latter to protect the yolk, which is the essential part, the true egg.

Now, it is well known that mere size does not enter into the determination of the real affinities of animals and plants. The smallness of the rat does not show that it is related to the frog rather than to the elephant, and from our present point of view the size of eggs is meaningless. The egg-cells are large in all birds and reptiles, in the sharks, rays, ganoids and Cephalopoda, small in mammals, bony fishes and nearly all invertebrates, intermediate in amphibians.

The various envelopes which eggs ever have, may be classed under four categories: *First*, a very thin and delicate one, the proper membrane of the cell itself, which ought always to be distinguished as the vitelline membrane; *second*, the ovarian envelope which is secreted around the egg-cell by the tissues of the ovary; *third*, the envelopes secreted by the oviduct, which may form an envelope of nutritive matter, or a protective shell, or both, as in the hen's egg, of which the nutritive white is secreted by the upper part, the calcareous shell by the middle part of the oviduct; *fourth*, coverings secreted by accessory glands, such as the slime in which the eggs of snails are imbedded, or the shells in which leeches lay their eggs. By adhering to this classification the student will be able to follow with profit the labyrinth of special description. To enter into further details would lead aside from the object of this article: let it suffice to have pointed out the possibility of manifold variations, and to have emphasized the fact that the egg-cell is the important and only essential part of an egg.

The egg-cell always arises from a germ-mass, called *Keimlager* in German. The germ-mass is at first composed of cells all essentially identical in microscopic appearance. Single isolated cells then transform themselves into eggs, while their surrounding fellow-cells play the rôles of nurses and purveyors. To avoid inaccuracy it must be added that in some cases the germ-mass does not consist of distinct cells, but contains numerous nuclei which ultimately become the centers of distinct cells; but before this separation the differentiation of the ova begins. In both methods of development some cells enlarge to form the eggs, others supply the enlarging and growing cells with nutritive material. It is impossible to enter upon this subject further than to say that the form and disposition of nutritive cells varies extremely in different animals, while the changes in the egg are much more uniform, so that it is possible to describe in general terms the development of the ovum.

The modifications which occur in the growing egg-cells are as follows:

1. Change of size: the cell enlarges, it being a rule, no exception to which is, I believe, known, that the mature egg-cell is much larger than any of the other cells in the body of the parent.
2. Change of shape: the cell becomes nearly or quite spherical.

3. The nucleus becomes larger, spherical, and assumes an eccentric position within the cell, while the meshes of the nuclear network are coarse, and few, and for the most part radiate from the nucleolus, which is large, distinct, highly refringent and placed eccentrically within the nucleus.
4. The cellular network becomes very distinct, its interspaces are filled with ovoid or round, solid enclosures, which are usually if not always mainly of an albuminoid character. These enclosures form the part which is called the deutoplasm by Edouard von Beneden and others. The deutoplasm causes the egg-cells to be called the yolk, because it is the nutritive matter from which the protoplasm of the cell grows. The term yolk has no very exact scientific meaning, for it is used to designate sometimes the deutoplasm alone, sometimes the whole egg, as when the segmentation of the yolk is spoken of.
5. A cell membrane appears, and usually acquires considerable thickness.

A typical mature egg-cell is shown in Fig. 1, which represent the ripe ovum of *Toxopneustes lividus*, the common sea-urchin of Europe. The nucleus is proportionately larger than in the eggs of many other animals, its contents are fluid except the net-work and the nucleolus (*n*), which latter frequently has one or more vacuoles. In some cases there are several or many nucleoli, as in osseous fishes, but the meaning of this difference is absolutely unknown. Moreover, this egg is unlike that of many animals in that the yolk spherules or the deutoplasm granules are comparatively small, while in some animals, especially those with larger eggs, the granules are larger. If these variations are borne in mind the figure given may be accepted as a correct representation of a mature egg-cell.

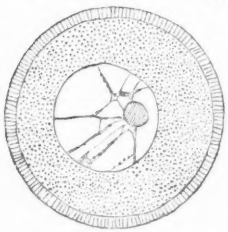

FIG. 1.—Mature ovum of sea-urchin, after O. Hertwig.

I am inclined to think that besides these peculiarities the ripe egg-cell shows a distinction between a thin denser peripheral layer of protoplasm immediately under the vitelline membrane and a central portion, which alone contains deutoplasm, recalling the differentiation of the ectosarc and endosarc in the Amœba. This feature has been observed in several cases, and further research may demonstrate it to be common to all eggs.

The shape of the egg does not necessarily remain spherical, but may be altered by external pressure, as when several are laid in one capsule (*Lumbricus, Nephelis, Planaria*, etc.), or when compressed by an unyielding shell. A very striking instance has recently been described by Repiachoff in the Supplement to Vol. xxx of the *Zeitschrift für wissenschaftliche Zoologie*. He describes the egg of *Tendra zostericola* (a European Bryozoön found on eel-grass) as having a fusiform shape, Fig. 2.

FIG. 2.—Egg of *Tendra zostericola*, after Repiachoff.

One other remarkable modification of the egg-cell occurs among spiders, and has not yet been observed in other animals. The eggs of some spiders (Fig. 3) contain, besides the nucleus, a second body, *k*, of about the same size as the nucleus, solid and resistant, and exhibiting indications of a series of concentric laminæ; this is probably only a specialized form of deutoplasm, similar to the four large oil globules described by Spengel in the eggs of *Bonellia viridis*.

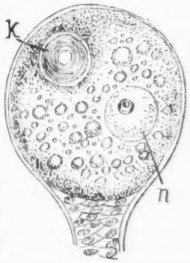

FIG. 3.—Egg-cell of *Tegenaria domestica*, after Balbiani; *n*, nucleus; *k*, laminate body.

When an egg-cell attains maturity, the first important and striking change that occurs is the translation of the nucleus close to the surface of the egg, where it disappears. The nucleus of the ripe ovum is usually called the germinative vesicle, and the phenomenon just alluded to is still generally termed the disappearance of the germinal vesicle. The fact has long been known, but was entirely inexplicable until the discoveries of the last few years afforded a partial explanation, by rendering it probable that the disappearance is not real but only apparent. The subject is still obscure, because the observers are not entirely agreed with one another as to the facts. The greatest difficulty arises from the fact that in most cases the egg-cell ejects two or three small bodies over the spot where the nucleus disappears. These bodies are called polar globules, and are known to occur in Cœlenterates, Echinoderms, Molluscs, various classes of worms, Tunicates, Ganoids and mammals, so that their existence in all cases might fairly be assumed, were it not that renewed special search for these bodies in Amphibia, by O. Hertwig, had failed to discover any trace of them. No

satisfactory observations of the polar globules of the eggs of any of the Rotifera or Arthropoda have yet been made; but, as the interest in this subject is very recent, the globules may yet be found in those classes.

When the polar globules *are* formed, the following events may be *assumed* probably to occur. Ed. van Beneden's account of the development of the polar globules in the rabbit may be especially mentioned as exceptional. The history as here given is based upon observations made upon a limited number of invertebrates. When the nucleus disappears it is replaced by a spindle-shaped body known as the *kern-spindel* or Anglice *nuclear spindle*, which is generally regarded as the metamorphosed nucleus. It consists (Fig. 4) of a small number of fine, parallel threads, which, converging towards either end, run out into two points. The fibres are all thickened in the middle at the same level; these thickenings produce the appearance of a distinct plate or disk in the middle (Strassburger's *Kernplatte*). It will be convenient to adhere to the term nuclear plate to designate these thickenings. The spindle lies perpendicular to the surface of the egg. The pointed end of each spindle occupies the center of a clear space, from around which radiate fine threads, thus producing a sun-like figure. The whole spindle, with the two suns, has been named the *amphiaster*.

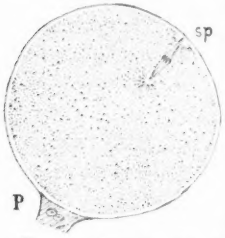

FIG. 4.—Ovarian egg of Hæmopis, after Hertwig; *sp*, nuclear spindle; *p*, peduncle attaching the egg to the ovary.

The character of the next series of changes is shown in Fig. 5. The spindle is partly excluded from the egg, one end projecting outwards and enclosed by a distinct mass of protoplasm, constricted around the base. The "kernplatte" has divided in two, one-half moved towards either end of the spindle. The spindle next divides and the inner moiety retreats into the egg, the outer into the protuberance, which thus becomes the first polar globule. The part of the spindle within the egg, transforms itself into a second spindle, which develops a second globule like the first. Frequently a third globule is also formed. The connection of the globules with the yolk lasts some time, and in the case of leeches is not dissolved until segmentation begins. These globules take no part in the further history of the egg: they disappear—how, is not

exactly known. The part of the spindle in the egg-cell, returns to the center of the egg and becomes a nucleus-like body, now termed the *female pronucleus.*

The egg-cell, therefore, divides into two parts, first, the egg proper with the female pronucleus, second, the polar globules. The egg-cell has become not as a whole, but partly, a real egg, the ultimate female sexual product. Since the use of the term egg cannot be restricted, and since precision of nomenclature is, in this case, particularly desirable, I have proposed the name *thelyblast* for the female element.

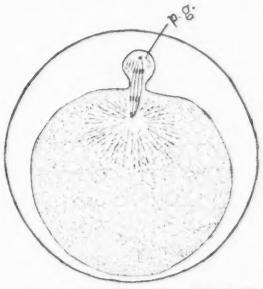

FIG. 5. — Egg of Nephelis three-quarters of an hour after laying. Formation of the first polar globule, after Hertwig.

We pass now to the history of the male elements, or spermatozoa, concerning which the observations of naturalists have been even less satisfactory. The adult spermatozoa have, with a few exceptions, an elongated, almost thread-like form, Fig. 6, and consist of a shorter and thicker portion, the head, *a*, a short middle piece, *b*, and a filiform tail, *d*, from which is suspended, in many vertebrates, a thin and very transparent undulating membrane, *c*. Innumerable modifications of this type occur by variations in the size and shape of the head and the length and thickness of the tail. In a few exceptional cases, as among the nematode worms, the spermatozoa exhibit absolutely no trace of this form, but are apparently constructed upon an entirely distinct type. A few species of invertebrates have two forms of spermatozoa.

FIG. 6.—Fresh spermatozoön of *Salamandra maculosa*, after Gibbes. *a*, head; *b*, middle piece; *c*, membrane; *d*, tail.

In a not inconsiderable number of invertebrates, we find so-called spermatophores. These are only bundles of spermatozoa enclosed in a protective covering or shell (Fig. 7). In Cyclops this shell is secreted by the efferent duct, around the spermatozoa, just as the shell is secreted around the eggs by the oviduct. The spermatophores of some animals exhibit a very complicated structure, and have curious forms.

Like the eggs, or thelyblasts, the spermatozoa are developed out of cells, each cell forming not one sexual element, as in the case of the egg, but several. Hence several young elements appear within the interior of one cell at once; therefore this one cell is called the *spermatocyst*,[1] while the young elements which are to become spermatozoa, are called *spermatoblasts*, and lie within the mother-cell or the cyst. The spermatoblasts appear at first as cell-like, spherical bodies, which may multiply by division within the mother-cell. Their development progresses in the ordinary type of spermatozoön by a gradual elongation, the nucleus forming the greater part of the head, and the protoplasm, the tail, as has been described in the NATURALIST for July, 1877 (p. 397). These changes are so striking that they have absorbed the attention of investigators; hence the relation of the spermatoblasts to the parent-cell has been far less studied than its importance demands. At present, certainly, it is impossible to give any general account of the development of the spermatozoa. I shall, therefore, confine myself to a *résumé* of Semper's observations of the process in the sharks, his being the most complete special account of which I know. The principal stages are represented in Fig. 8, which are taken from preparations stained with hæmatoxiline.

46.

FIG. 7.—Spermatophore of *Cyclops quadricornis*. *m*, covering membrane or shell; *sp*, spermatozoa.

In the earliest stage the spermatic follicle, or ampulla, *a*, is a cavity occupied by the remnants of a cell, which soon disappears. This cavity is lined by a layer of cells with large spherical, granular nuclei, and enclosed by an outer layer of cells with smaller dark, oval nuclei. The inner layer alone is directly concerned in the formation of the spermatozoa. In each one of the inner cells, which are the spermatocysts, the nucleus begins to multiply, as shown in *b*, *c*, *d*, *e*, dividing every time into two parts, one of which remains at the inner extremity of the cell and preserves the character of the parent nucleus, while the other recedes towards the outer end. The parent nucleus then again divides, until finally the spermatocyst contains one mother nucleus (*mutterkern*), and several daughter nuclei, which are easily distinguished by their

[1] The term spermatocyst has been used in various senses, but I believe the definition above given accords with the usage most widely accepted.

spherical shape and finely granular appearance. The daughter nuclei multiply by division. While these changes occur, the whole cell or spermatocyst becomes greatly elongated. At the completion of this stage, the parent nucleus at the inner end of the cell disappears, and a nucleus similar in appearance appears at the outer end, *f*. It is probable, but not demonstrated, that the two nuclei are identical, in other words, that the parent nucleus

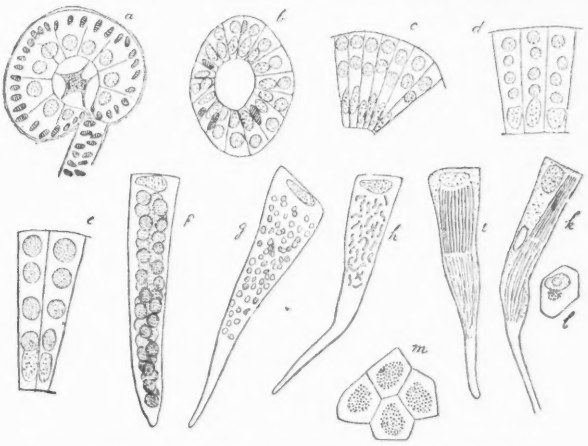

FIG. 8.—Development of the spermatozoa in sharks, after Semper.

migrates from one end to the other. The upper nucleus henceforth is passive, remaining behind to degenerate after the spermatozoa have been discharged from the cyst. Each one of the daughter nuclei, after subdividing still further so as to become very small, *g*, gathers a distinct mass of protoplasm around itself, and becomes a *spermatoblast*. The further development proceeds by alteration of the shape of these bodies: the nucleus elongates, becomes S-shaped, *h*. The elongation advances, the nuclei become straight and rod-like, and lie parallel to one another in the upper end of the cell, *i*. If we look at the cells from the outer surface of the ampulla, the center of the end of each cell is occupied by a cluster of dots corresponding to the bundle of rod-like nuclei seen endwise, *m*. Each long nucleus forms a spermatozoön head, which is connected with a thread-like tail. The development is completed by the discharge of the bundle of spermatozoa, leaving the large nucleus behind.

The essential feature of this whole history is, that a cell with a

single nucleus divides to form a compound body in which there is one large element with one kind of nucleus and numerous small elements, all with nuclei similar among themselves, but different from the single larger nucleus. The same thing occurs when the egg *sensu stricto*, or the thelyblast, is developed. In the case of the egg, it is the larger element which is preserved as the *female* part; in the case of the spermatocyst, it is the smaller elements which are preserved as the male parts. The two processes are complementary.

These facts have led to the following hypothesis of the relation of cells to the sexual elements. In an ordinary cell the two elements are intimately united in a latent condition, so that an ordinary cell is hermaphrodite or neuter, sexless, by which I mean it has no sexual differentiation. Diagrammatically this condition may be represented by Fig. 9, *A*. To form an egg the male portion is removed in several parts, which are the polar globules, while one large portion becomes the egg or thelyblast, Fig. 9, *B*. To form the spermatozoa, the two elements separate, the mother nucleus, or female part, remains behind, and if my hypothesis is correct, it, as well as the egg, must be called a thelyblast; the spermatozoa are discharged, and are capable of further vitality. They are the homologues of the polar globules. For both structures the common name *arsenoblast* has been suggested. If the above hypothesis is valid, then there is a fundamental distinction between cells on the one hand, and the *genoblasts* (the sexual products) on the other—every genoblast contains only one sexual element, every cell contains both. When sexual reproduction occurs, a thelyblast from one source unites with an arsenoblast from another source—the two by their fusion complete a perfect cell, which is called the impregnated ovum. In the next article this process will be described.

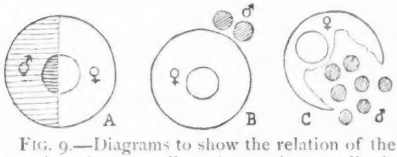

FIG. 9.—Diagrams to show the relation of the sexual products to cells. *A*, an ordinary cell; *B*, egg with polar globules; *C*, spermatocyst with spermatozoa.

In conclusion I wish to repeat that the conception of sex here advanced is only an hypothesis, which further research may cast aside, but which I hope may be confirmed, because it is already possible to bring forward many strong arguments in its favor.

For the convenience of those who may wish to pursue these subjects further, I quote below some of the principal articles, especially those which contain further bibliographical references :

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THE CONVOLUTION OF THE TRACHEA IN THE SANDHILL AND WHOOPING CRANES.

BY THOMAS S. ROBERTS.

IT is well known to ornithologists, that in many birds there are various peculiar modifications of the trachea, or windpipe, which, it is supposed, serve the purpose of adding some particular quality to the voice. Passing by the numerous minor instances of this structure as seen frequently in ducks, in some geese and a few other birds, we find it most strikingly exhibited among the cranes and swans. In certain species of these two groups the trachea enters the enlarged and excavated keel of the sternum, and after a number of convolutions, varying in position and extent with the species, passes out at the place of entrance and thence into the lungs. In such cases, at least, it is plainly great strength and volume of tone which are imparted, as is clearly evidenced by the powerful utterances for which these birds are noted.

It is the present purpose to speak of this point of structure only as it exists in the two American species of cranes, *Grus americana* and *Grus canadensis*, with special attention called to its presence in the latter.

That the trachea is remarkably convoluted within the sternum in the whooping crane (*G. americana*) has been pointed out and fully described by Dr. Elliott Coues, in his "Birds of the Northwest." But the mistake is there made of stating (on the evidence of others, I believe) that in the sandhill crane (*G. canadensis*) the trachea is simple; and this supposed entire difference between the two species is presented as strong anatomical evidence of their distinctness.

The fact is, however, that the trachea *is* convoluted within the keel in the sternum in *G. canadensis* as well as in *G. americana*. This I have determined by the examination of four sterna of *canadensis*, three of which were prepared by myself from birds positively identified as *canadensis* by the generally recognized external characters. Two sterna of *americana* have been examined: one the same that was described by Dr. Coues, and with which I have had the opportunity of comparing specimens through the courtesy of Dr. R. O. Sweeny, president of the St. Paul Academy of Natural Sciences; the other a specimen recently prepared by Mr. Wm. Howling, taxidermist, of Minneapolis, Minn., and in whose collection I saw the adult bird from which it was taken. One side of the keel was neatly cut away by Mr. Howling, at my suggestion, and the specimen freely offered for use in the present connection. It is identical in structure with the St. Paul specimen, and is the one from which the drawing has been made.

Although there is not such a radical difference as supposed by Dr. Coues, yet the two species are distinct in respect to their tracheal and sternal development. A glance at the drawings will show this at once. They are alike in so far as the trachea enters the sternal keel in each. But in *canadensis* the whole sternum is smaller and less stoutly developed; the coils of the windpipe are confined to the anterior half of the keel, and it is this portion alone that is enlarged; there are only about eight inches (average of four specimens) of windpipe in the keel, to twenty-seven inches (average of two specimens) in *americana*; the walls of the sternal cavity are much more imperfectly ossified than in *americana*, where they are everywhere on the outside dense, hard bone. On

the whole the entire conformation of the trachea and sternum in *canadensis* is much simpler than in *americana.*

Although only the anterior portion of the keel is enlarged for the reception of the trachea in *canadensis*, yet the remainder of

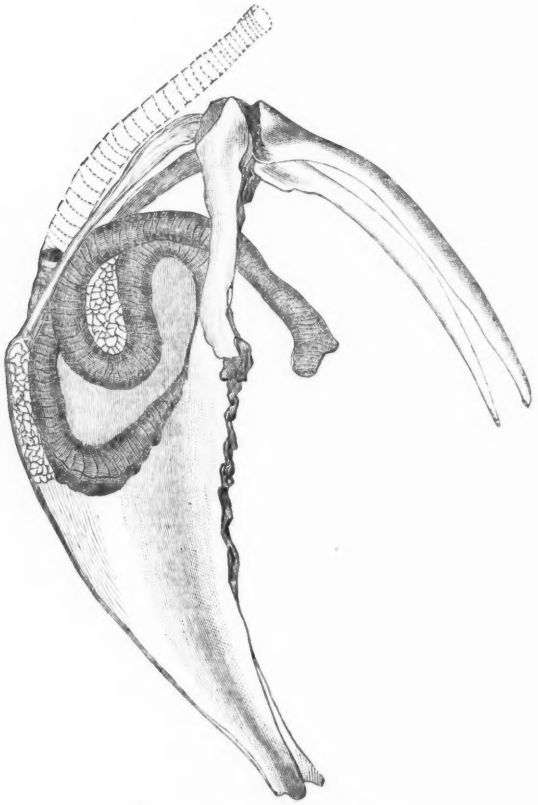

FIG. I—*GRUS CANADENSIS.*

the keel is not solid bone; but, instead, is composed of two frail plates separated by a thin layer of bony meshwork. This light structure of the posterior part of the keel is more pronounced in some specimens than in others, reaching the greatest development yet seen, in a sternum which shows also the greatest convolution of the trachea.

The following short description of the course of the trachea within the keel in *canadensis* will be sufficient in connection with the drawing presented: Entering the keel at its lower anterior angle, the trachea follows the lower edge of the keel for about an

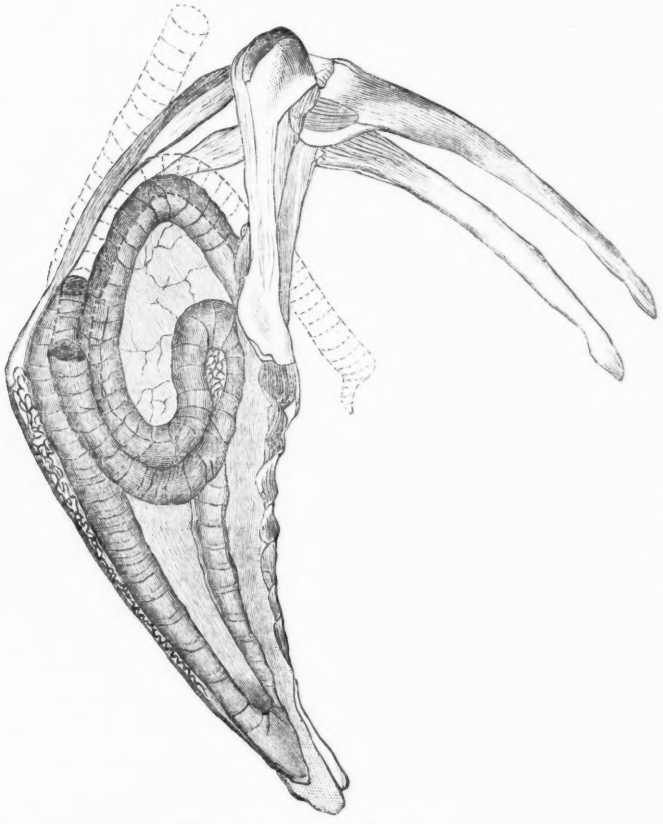

FIG. II—*GRUS AMERICANA.*

inch and then curves strongly upward and forward, until it has turned nearly one-half of a circle, when it passes by a scarcely perceptible curve to the upper anterior point of the sternum; lying for a part of the distance in a groove formed for its reception in the body of the bone and which is visible as a semi-cylindrical projection on the inner surface of the sternum in front.

From here the trachea reaches the point of entrance by a strong double curve, forming a figure which is a perfect letter S, the lower turn being within the first large coil, and the upper following the anterior outline of the keel. The cavity is three and one-quarter inches long, just one-half of the entire length of the keel. There are two unoccupied spaces between the coils—a small one filled with bony meshwork and a larger one entirely hollow. This description is from the specimen figured, which has been selected as representing very nearly the average of four. Two others show some variations worthy of mention. In a large sternum from a female bird, there is less convolution and fully two inches less of windpipe inside the keel. The upper loop does not fill the anterior part of the cavity, and on entering the keel the trachea does not go as far back or form the same kind of curve. But little more than one-half of the length of the keel is excavated. The third specimen shows a higher development than the one figured. The coils are large and occupy nearly the entire hollow, which is fully one-half the length of the keel. The posterior lower edge of the keel is thickened—much like the same part further forward—and cancellated inside; while the walls of the anterior cavity are more fully ossified than in either of the others.

In an embryo crane,[1] stated to be the sandhill, which was just about to break the shell when collected, the trachea does not enter the sternum at all and is perfectly simple. But the anterior part of the keel, which is, of course, entirely cartilaginous and very diminutive, is, comparatively speaking, much thickened, and a cross section shows it to consist of two thin walls separated by a marrow-like substance. In this feature of the sternum, we see the only indication in the embryo of the singular structure to be developed later in life. The degree of complexity of the trachea is thus shown to be dependent upon age, and the variations just alluded to are no doubt fully accounted for by this fact.

It is unnecessary to frame a new description of the convolutions of the trachea in *americana*, as that furnished by Dr. Coues is excellent. The following extracts from it are given for the convenience of the reader. "The sternal keel is broad and tumid, and is entirely excavated. The greater part of the excavation is occupied by the singular duplications of the trachea; * * but

[1] This specimen was obtained in the northwestern part of Minnesota, by Mr. Nathan Butler, and is now in the collection of the Minn. Acad. of Nat. Sci., Minneapolis, Minn.

there are two—an anterior and a posterior—large empty air cells in the bone, with smooth walls, and two other air cells—one superior and one along the edge of the keel—filled with light bony meshwork. * * * The trachea, entering the apex of the keel, traverses the whole contour of the keel in a long vertical coil, emerges at the front upper corner of the keel, enters again at the lower corner of the keel, and makes a smaller vertical coil in the center, emerging again where it went in. On looking at the object from the front, we see three parallel vertical coils side by side; the middle one is the trachea coming down from the neck above; on the left hand is the bulge of the first great coil; on the right is the windpipe passing to the lungs after it has made its second coil inside."[1] Following this is a statement to the effect that "there are about twenty-eight inches of windpipe coiled away in the breast-bone," and that altogether, from the upper larynx to the bronchi, the trachea is fifty-eight inches in length, and this in a bird that is little over four feet long from the tip of the bill to the end of the tail.

The average of three specimens shows the entire length of the trachea in *canadensis* to be about twenty-seven inches.

Audubon, who regarded *G. canadensis* as the young of *G. americana*, has, curiously enough, left us a description of the tracheal apparatus of the former but not of the latter. His description is taken from the sternum of a crane which he kept for a season in confinement, and which the reader would be led to infer turned white while in Audubon's possession, though this change of plumage is not directly stated to have occurred. I quote the brief description which, it will be readily seen, applies to *canadensis* and not to *americana*: "The trachea, which is thirteen inches long to its entrance between the crura of the furculum, passes into a cavity in the sternum where it curves so as to describe two-thirds of a circle, returns on the right side and enters the thorax by curving backwards. The cavity of the sternum is two inches long, with an equal depth, and a breadth of three-quarters of an inch. The ridge of the keel is, at its fore part, three-quarters in breadth, and contracts to one-half inch at its junction with the angle of the furcula, which is continuous with it. * * * * Boston specimen." It is strange that Audubon, who appears to have been a close

[1] Besides at page 530 of "Birds of the North-west," this description may also be found in full in *Forest and Stream* for Aug. 20, 1874.

observer of the general anatomical characteristics of his subjects, never examined the sternum of the adult *G. americana*, but only of what he considered the young. Yet we must conclude this to have been the case, for had it been otherwise, we certainly should not have been left with only the above description given without comment.

In conclusion, I cannot refrain from alluding to a subject which it were better, perhaps, to leave untouched at this time. In making careful, detailed comparisons of the several sterna in my possession, in order to determine exactly in what particulars the two species differ, I could but notice that only two important conditions need be fulfilled to change the sternum of *canadensis* into that of *americana*. If the remaining portion of the keel in *canadensis* were thickened and hollowed, and the trachea should gradually increase in length, the arrangement seen in *americana* would certainly result, for the disposition of the trachea in the latter species is exactly what would be produced by its forcing itself into the narrow limits of the keel. This may be simply an interesting relationship existing between the two structures, or it may have a deeper significance as the nature of the variations among the sterna of *canadensis* pointed out above, seems to imply. But considerations of this nature must be left for further investigation—until material of a determinative kind has been obtained.

EXPLANATION OF CUTS.

FIG. 1.—Sternum and lower part of trachea of the sandhill crane, *G. canadensis*. The left wall of the cavity has been removed, showing the trachea coiled away inside.

FIG. 2.—The same of the whooping crane, *G. americana*. The entire left side of the keel has been cut away to show the interior. The scapulars, clavicles and coracoids are in position in each.

These drawings were very kindly made for the illustration of this article by my friend, Mr. C. L. Herrick. They are about one-half natural size.

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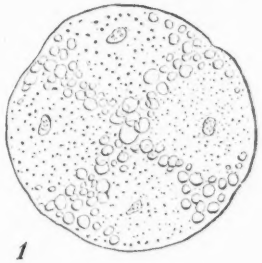
THE DEVELOPMENT OF MOINA.[1]

BY J. S. KINGSLEY.

DR. Carl Grobben having recently published one of the most complete accounts of the development of one of the Daphnidæ which has yet appeared, an abstract of his paper may prove of value to American naturalists.

[1] Die Entwickelungsgeschichte der *Moina rectirostris*. Arbiten aus dem Zoologischen Institute der Universität. Wien. Tom. II, 2 heft, 1879, pp. 66, pls. 7.



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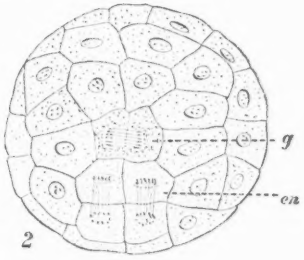
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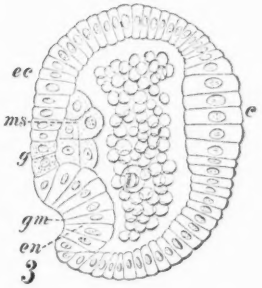
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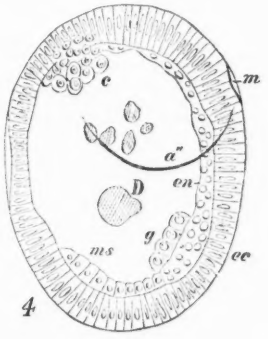
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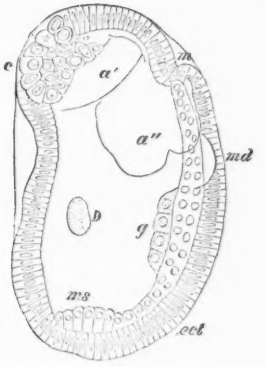
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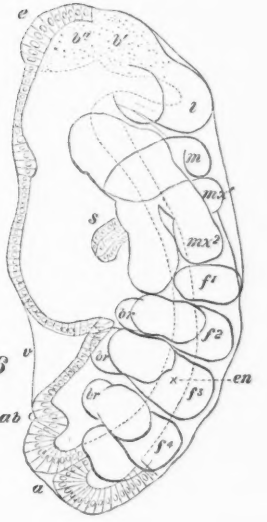
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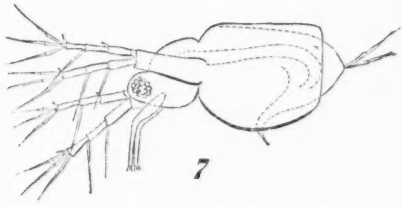

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The eggs of Moina are oval and measure about one-tenth of a millimetre in length. Segmentation occurs first on the minor and then on the major axis, thus producing four cleavage spheres. A polar view of these is shown in Fig. 1, the food granules (*deutoplasm*) being seen between the blastomeres. Another division produces eight segments, but after this, cleavage takes place at unequal rates in different parts of the egg. As we understand the matter, these cleavage planes do not all pass completely through the yolk. In the resulting mulberry stage the "genital cell" (which afterwards produces the genital system) is differentiated even before the first signs of the gastrula stage. (Fig. 2 *g*, genital cells or the cells which by invagination produce the endoderm. In these cells the so-called *Amphiaster* is shown.) Soon there begins an invagination of the endodermal cells, and other cells arise beneath the ectodermal cells near the genital cells. These form the mesoderm. Others, opposite the genital cells, are larger, and these form the cephalic germinal plate, "scheitel platte." (Fig. 3, an optical section; *ec*, ectoderm; *ms*, mesoderm; *g*, genital cells; *g m*, gastrula mouth; *en*, the cells which form the endoderm; *c*, cephalic germinal plate; *D*, deutoplasm.) Then the gastrula mouth closes up, the genital and endodermal cells become internal, the body is constricted and a fold is formed on either side, the first indication of appendages, which develops into the second antennæ. A depression occurs in the ectodermal cells, where finally the mouth appears. (Fig. 4, lettering as before; *a''*, second antennæ; *m*, depression for mouth.) In the next phase two more appendages have budded, the antennulæ and mandibles, while the antennal bud becomes two-lobed. This constitutes the nauplius stage. (Fig. 5, *a'*, antennulæ; *md*, mandible.) Next, two of the thoracic feet are indicated, then two more, the brain begins to appear, the mouth depression is deeper, the anus is indicated and the genital cells divide and are placed on each side of the median line. Then the maxillæ and the fifth pair of feet appear; the eye begins to be developed from the ectodermal cells, the shell gland is present and the abdominal bristles are outlined. (Fig. 6, *b' b''*, brain; mx^1 mx^2, first and second maxillæ; f^1–f^5, thoracic feet; *br*, branchial sacs; *ab*, abdominal bristles; *a*, anus; *s*, shell gland; *v*, vitelline membrane; other letters as before.) The succeeding changes are those of increase in size of the appendages, in which joints appear, the formation of the shell, appearance of heart and the covering of the eye, and at last the animal acquires the perfect form (Fig. 7, from Baird).

EDITORS' TABLE.

EDITORS: A. S. PACKARD, JR., AND E. D. COPE.

——In our last number we called attention to the status of the modified organization of the Academy of Natural Sciences of Philadelphia, which was adopted four years ago. We also referred to a document relating to it, which was recently issued by a majority of a meeting of the council of that body. We criticised this document adversely, but did not enter into a detailed examination of it, thinking that the general confusion of ideas and unworthiness of sentiment to be found in it, were too self-evident to require refutation. Since, however, many of the members of the academy have voted to support the policy which is embodied in it, some of whom have not understood its drift, while others have not even read it, we give space to a criticism of some of its salient points.

From the positions assumed by the author of this document, we select the following:

(1.) "Under the letter and spirit of the by-laws, the professors constitute, in fact, a class of beneficiaries of the academy. * * It is not apparent that it is essential to the prosperity of the academy to admit any class of its beneficiaries or subordinates to participate in the administration of its affairs. Nor is it manifest that their studies or the performance of their prescribed duties would be facilitated by their being made members of the council for life" (p. 9). Imagine language like this addressed to the academicians of Paris or St. Petersburg! And the presence in the council of two paid employés of the academy at the present time, has never disturbed any one's composure, probably because they are not likely to be candidates for professorial honors.

(2.) "Those students who are not obliged to follow a vocation for a livelihood are not in need of the benefits of a professorship, or of the Jessup Fund, to enable them to pursue their studies in the academy" (p. 9). So then, Hébert and Gaudry, and others, are not eligible to chairs in the Jardin des Plantes and the Sorbonne, because they are rich; and so with many others in all parts of Europe! But there are reasons other than the possession of pecuniary means, why a man should not be a professor in the academy; for,

(3.) "The professors are to have custody of all the collections in the museum, worth together, possibly, a quarter of a million

of dollars. They give no valuable security or pledge to be forfeited should they fail to preserve the integrity of the collections. * * No better opportunity can be offered to tempt men to enrich their private cabinets at the expense of the academy than this proposition presents. It is not prudent to expose the property of the academy to such chances without any check or protection under its own laws, and confide it unreservedly to the purity and incorruptibility of the professors and the laws which inflict punishment for larceny and burglary." The author of this language does not seem to be aware that it must excite astonishment in the minds of scientists everywhere, and that it is a boomerang which recoils upon the policy he supports. If there is any class of persons to whom property of an academy of sciences should *not* be entrusted, it is the amateurs and collectors who do not make original research their profession. Now too lax in administration of a collection, some accident occurs; then too strict in their surveillance, collections become practically inaccessible. Not knowing the value of material from the standpoint of research, they accumulate show collections, and neglect the fields where science reaps her true harvests. The true scientist does not care to possess collections, excepting so far as they are necessary for the prosecution of research, and depredations on museums do not come from this class. Once in charge of a museum of importance, they naturally take pride in it, and spare no pains to preserve in it all records of scientific work. This can never be felt by the mere employé, nor by the average corporation trustee. Neither class can criticise the work of the specialist as the specialists can each other. Not to enumerate self-evident truths, the sum of the matter is, that this document desires the exclusion from the administration of the collections, the only persons who are competent for the work. It demands security from these, while none is required at present from men who are entirely ineligible.

We do not believe that a majority of the members of the academy are prepared to sustain the above positions, but suspect that their votes have been influenced by consideration of the three following very misleading statements, which form the recapitulation at the close of the paper under consideration.

(1.) We quote: "It is notorious that the Academy, since its beginning in 1812, has been managed chiefly by, and always in the interest of its experts, those members most distinguished for their learning, and students" (p. 10). This we deny; and in evidence state that instead of its being managed by its experts, there are, at present, in a council normally of twenty-three members, but four who make the pursuit of science their business, but two of whom are officers of the academy, and only one of whom is a curator. Moreover, the by-laws expressly provide that the prospective professors *shall not be members* of the coun-

cil. Whether it is managed in the interest of the specialists may be inferred from the fact that most of these gentlemen do their work at private houses and do not place their collections in the building of the academy. It is undoubtedly to the interest of the original investigator, at the present time not to work there, and many reasons for this may be elicited, on enquiry, by any one interested in pursuing this part of the subject.

(2.) It is objected, in various paragraphs that "the effect of the proposed alteration will be to make the council ultimately consist of twelve professors elected by the council for life and the eleven officers of the academy elected annually for one year. The officers of the academy will always be a minority in the council, and when one person fills two offices this minority will be more decided." In our opinion this provision is an important element in the proper administration of the affairs of an academy of sciences. The development of science being the primary object of the institution, those persons who devote their time to it should constitute a majority of its management, while others may be called in as important aids and counsellors. In institutions having other objects it is customary to call in scientific experts as aids, but not to make them a majority of the management. It is also evident that the specialists are the best, if not the only critics of each other's conduct, while the supposition that they will combine to plunder the academy, is preposterous. But here let us observe, that as the by-laws provide that the council shall elect the professors, the matter is in their own hands as to what class shall be in the majority. Hence the statement that the new by-law discussed, at once creates a majority of professors in the council, is erroneous. And it was on this false issue that the late election was probably decided. It will be very easy to rectify any defects of this part of the plan, if necessary.

(3.) "The appointment of professors cannot be reasonably expected until endowments for their compensation have been obtained." This proposition has been put forth *ad nauseam* by the opponents of the plan under discussion. Having excluded professors from council, they ask for applications, and because there are none, expect us to believe that the plan "has failed" for want of funds. They ignore the fact that the curators who now perform the more laborious part of the work of the proposed professors are not salaried officers, though they employ one of their own number to fulfill certain duties. They forget that one professor has been appointed and is performing his duties. They do not realize, perhaps, that the learned conservator of the conchological section is, in all important respects, professor at the present time. And such has been the advantage of this arrangement, that that department has expanded into the most extensive one in the institution. Why cannot other departments be similarly administered? The scientists of the city who are working in their

own studios are certainly not getting salaries for it! It is to the advantage of the academy to utilize, if possible, all these now scattered ways and means. And is it not a reflection on human nature that suggestions to this end should be looked upon as "Macchiavellian schemes for selfish ends," or attempts to obtain control of the academy's collections? We want no better evidence than such language, to show that something more important than money is wanting here. The need of something else was very evident during our Centennial, when enormous collections, which might have been had for the asking, were allowed to be taken to Washington under our very eyes.

We close with an allusion to the opinion expressed in this part of the paper, that "the professors would be the only experts who would have free access to the collections." There is no provision to this effect expressed or implied in the by-laws or the proposed alteration of them. The by-laws provide for the reverse. The privileges now enjoyed by members of the academy would not be restricted in the least, but would rather be increased through the additions to the collections which would follow. The new by-law simply protects the new material which may hereafter be obtained through the exertions of a professor for purposes of research, from distribution through the museum, before it is used, and specifies who shall use it first. This is simple justice, and it will ever remain the condition on which the academy's collections can be increased in any important degree. Expectations of obtaining collections in any other way are illusive. By new material is not meant material new to the museum, but that which is new to science. At present, this entire subject, which is the working basis of the institution, is thoroughly misunderstood. It is not well to fear the granting of these privileges, for it is a question of their being enjoyed by a few persons or by none at all. No two persons can use the same material at the same time, nor can its first use be enjoyed by more than one person.

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RECENT LITERATURE.

NOTES ON NEW ENGLAND ISOPODA.[1]—In this paper we have a list, with notes on the distribution, of forty-three species of Isopoda found on the coast of New England (including one which has not yet been observed south of Labrador). *Janira spinosa* and *Leptochela rapax* are the only new species described. Of these forty-three species, ten have been found only south of Cape Cod; fifteen are common to both sides, and eighteen appear only north of the cape, and eleven occur on the European shores. Of these eleven, *Tanais vittatus* has been found south of the

[1] *Notes on New England Isopoda.* By OSCAR HARGER. Proceedings of the United States National Museum, 1879, pp. 157–165.

cape but not north, while *Jæra albifrons* (*copiosa* Stm.), *Idotea irrorata*, *Limnoria lignorum* and *Leptochela algicola* are found on both sides of that promontory. In the paper we notice that no species of Bopyridæ (with the exception of *Cepon distortus*) is reported south of Massachusetts. Dr. Leidy informs us that during the last summer he found *Crangon vulgaris* at Atlantic City, N. J., badly infested with another species.—*S. S. K.*

Carcinological Papers of Paul Mayer.[1]—We have here two papers, one on the color changes of the Isopoda, the other descriptive of a new parasitic crustacean, *Ive balanoglossi*, found, as the name indicates, in the body cavity of *Balanoglossus*. The sexes closely resemble each other, except that the males are much the smaller. The body is not segmented, but the five pairs of appendages which are present show their articulate character more plainly than in many Lerneans. The stomach is a blind sac, and the circulatory apparatus is wanting. The male adheres to the female near the genital opening. Dr. Mayer succeeded in rearing the Nauplius from eggs.—*S. S. K.*

Herrick's Entomostraca.[2]—It is occasionally our lot to run across the productions of some naturalist, who, laboring under the impression that the scientific world has been at a standstill for a quarter of a century, deems it his duty to start it, and the result is almost invariably the same, it retards the motion which, though inappreciable to his senses, nevertheless existed. The time necessary to unravel the confusion produced in synonymy by such persons is enormous, and the amount of work required can only be appreciated by the systematist.

Such a work is now before us and seems to demand some slight attention. The author seems to have had very slight access to the literature of the subject, and to be entirely ignorant of any work done since the days of Baird's British Entomostraca (1850), and Dana's Crustacea of the U. S. Exploring Expedition (1852), the works of Claus, P. E. Müller, G. O. Sars, Lilljeborg, Brady, Birge, etc., being unknown to him. The synonymy quoted, however, would at first sight indicate an extensive acquaintance with the bibliography, but a slight examination shows that all references are taken second-hand and no credit is given; for instance, fifty-five references are quoted from *Daphnia pulex* verbatim (but owing to careless proof reading not literatim) from Baird's British Entomostraca, and we would venture to say not one of them has been verified by our author, and what is more, his Pierian font, Baird's work, is not quoted at all in connection with that species. We had supposed that the classification of the lower crustacea

[1] Mittheilungen aus der Zoologischen, Station zu Neapel. 1 bd. 4 heft, page 515–522 one plate, 1879.

[2] Microscopic Entomostraca, by C. L. Herrick, in the Seventh Annual Report of the Geological and Natural History Survey of Minnesota, 1879, pp. 81-123. Pl. 21.

was in passable condition, but we are informed [p. 84] that "it is not possible at this stage of the study to attempt a systematic arrangement." On page 85 it is stated that the Rhizocephala and and Cirripedia "are enclosed in a hard shell-like test," which is true of no adult; Rhizocephala and some barnacles are exceptions. On the same page we are told that the sucker-like organ on the head of *Sida* corresponds to the pedicle [peduncle] of the barnacles, a statement showing very elastic ideas of homology. Our author, also contrary to the ideas of the best morphologists, recognizes an ocular segment, and excludes the telson from a position among the somites of the body. The NATURALIST is not the place, nor have we time to rectify the synonymy of the forms described, and to assign them to their proper position, but several forms, if the drawings are accurate, are placed at least in wrong genera. The typographical errors are numerous; Desmarest's name appears with three different orthographies, the abbreviation "Enc. méth" under three distinct forms. Lovén as "Loren," somite as "somnite" on p. 90, occurs the word "setigiferous," but the worst of all is "qualities" for gnathites (p. 86).

The illustrative figures are clearly printed, but of their accuracy we are not certain, and many points which are important from a systematic standpoint are slighted or ignored, thus rendering it difficult for the future reviser of the American species to classify the forms here described, and a quotation from p. 86, seems to exactly describe the condition of affairs brought about by this work. The curious misapprehensions and inaccuracies into which authors have fallen still further complicates the matter.—*J. S. Kingsley.*

THE MISSES JONES AND SHULZE'S NESTS AND EGGS OF THE BIRDS OF OHIO[1]—The just appreciation and cordial encouragement accorded by scientific critics to Part I, of this beautiful work must have prepared a welcome on the part of the public for the further installment issued in October last. Not only does its unique *ensemble* render it attractive, but it presents a combination of the useful and the agreeable of science and of art, to a very rare degree. In these days, when the great majority of periodical publications afford specimens of the progress in art-culture in this country, and the public grows more capable of criticizing the results of original efforts with the pencil and brush, such work as the talented and enterprising authors of these "Illustrations" have wrought, will be justly ranked high in general estimation. The originality of method of this work, which copies some of the prettiest and most varied objects in nature, the pleasing combinations in the drawings, the faithfully imitative style of coloring, and the tasteful finish of the text,

[1] Illustrations of the Nests and Eggs of the Birds of Ohio. With text. By Genevieve E. Jones and Eliza J. Shulze. Folio. Published by the Authors. Circleville, Ohio. (Part II.)

render these folios almost matchless as contributions to natural science, and to picturesque art for the library or for the parlor table. The sad death of one of the authors, in early life, and in sight of the goal of success, has added an appeal to our sympathy to the just claims of the work upon public appreciation. Miss Jones died last August, of a fever doubtless aggravated by her earnest efforts and mental anxiety concerning her work, though that portion of her labor already accomplished will be incorporated in the numbers of the publication yet to appear, Miss Shulze is engaged with Miss Jones's parents in the completion of the plan in which the two ladies originally joined; and Miss Jones's name will continue to be appropriately connected with that of the surviving *collaborateuse*. The present part gives three illustrations, being those of the Indigo bird, *Cyanospiza cyanea*, the marsh blackbird, *Agelæus phœniceus*, and the kingbird, *Tyrannus carolinensis*, with text of the crow blackbird, *Quiscalus æneus*. The work will continue in parts until the 100 plates are completed.—*Sarah O. Aiken, Washington, D. C.*

Nicholson's Manual of Palæontology.[1]—The present book consists of two volumes of nicely printed text, illustrated by many good engravings. The attractive appearance of the "Manual," and the fact that it contains a good deal of information, compiled from many sources, produces a favorable impression, and leads one to expect an able treatment of the subject matter. So far as regards the department of *Vertebrata* we are disappointed. The work, doubtless, has a value in bringing to the notice of students a considerable number of extinct forms, by furnishing good wood engravings. The cuts of recent Vertebrata are generally bad. But the definitions, especially those of the higher groups, are exceedingly defective, and the classifications adopted are generally antiquated or incorrect. In old world palæontology we find, for instance, the classification of *Stegocephali* ("*Labyrinthodontia*") of Mr. Miall incorporated bodily; a system, if such it can be called, where all sorts of characters have been put to impossible uses, and the laws of nomenclature extensively disregarded. Especial prominence has been given to American palæontology, but it is evident that, to use a political phrase, the delegation from the United States has been "fixed." The author has profited singularly little by the publications of the General and State Governments of America, but has apparently taken as his guide, Prof. O. C. Marsh's address before the American Association for 1877. This paper is well known here as little more than a record of what is taught by its author to the exclusion of other authorities, and on this account

[1] *A Manual of Palæontology for the use of Students, etc.* By Henry Alleyne Nicholson, Prof. of Nat. History in the University of St. Andrews. 2 vol. Wm. Blackwood & Sons, Edinburgh, 1879.

does not represent the subject to which it refers. If the author of the manual under review will examine into the claims of the nomenclature he has so extensively quoted from this source, he will find that a great part of it has either no foundation in analytical work, or has been proposed without regard to priority. Such are *Dinoceras*, *Brontotheridæ*, *Pliohippus*, etc., etc. The erroneous figure of the skull of *Coryphodon* is copied, when a correct one could easily have been found. Further attention to this department will enable the author to do it justice in a future edition.

RECENT BOOKS AND PAMPHLETS.—Anales del Museo Nacional de México. Tomo I, parts 1 to 7; pp. 399, pls. 13. Mexico, 1877-79. From the Museum.

The Monthly Journal of Science, and Annals of Biology, Astronomy, Geology, Industrial Arts, Manufactures, and Technology. 8vo, Vol. I, 3d Ser., No. LXXII, Dec., 1879. London. From the editors.

Bulletin Mensuel de la Société d'Acclimation. 3e Serie, Tome VI, No. 10. Paris, Oct., 1879. 8vo, 545-608. From the society.

The American Journal of Science and Arts. 3d Series, Vol. XVIII, No. 108. New Haven, Dec., 1879, with pl. III. From the editors.

Cerebral Topography. By S. V. Clevenger, M.D. (Repr. from Jour. of Nervous and Mental Disease, Oct., 1879). 8vo, pp. 27, 1 pl. From the author.

Geological Survey of Alabama. Report of Progress for 1877 and 1878. By Eugene A. Smith, Ph.D., State Geologist. 8vo, pp. 138, 3 maps. Montgomery, Ala., 1879. From the author.

Natural History Notes in Western North Carolina. By John T. Humphreys. Paper No. 10. A Hunt for Platinum in the Mountains of Western N. C. Single sheet, no date. From the author.

Proceedings of the Academy of Natural Sciences of Philadelphia, Pt. II, 1879. From the society.

Description of twelve new fossil species, and remarks upon others. By S. A. Miller. (Extr. from the Journ. of the Cincinnati Soc. Nat. History, July, 1879). 8vo, pp. 15, pls. 2. From the author.

Dr. H. G. Bronn's Klassen und Ordnungen des Thier-reichs, wissenschaftlich dargestellt in Wort und Bild. Gliederfüssler: Anthropoda, 28 und 29 Lieferung. 8vo, pp. 1201–1320. Säugethiere, 23, 24 und 25, Lieferung. 8vo, pp. 449–544, 7 pls. Leipzig and Heidelberg, 1879.

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Bulletin of the Torrey Botanical Club. 8vo, Vol. VI. Nov., 1879. From the Club.

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The Mound Builders: Being an account of a remarkable people that once inhabited the valleys of the Ohio and Mississippi, together with an investigation into the Archæology of Butler Co., O. By J. P. MacLean. Illustrated. Sm 8vo, pp. 233 and a map. Robt. Clarke & Co., Cincinnati, O. 1879. From the publishers.

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The Meteorologist, Vol. I, No. 9, Nov. 1879. Greensburg, Pa. From the editor.

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GENERAL NOTES.

BOTANY.

Fertilization of Flowers by Humming Birds.[1]—For several years some persons of this place have been watching the birds about flowers. They visit flowers for at least two objects, for insects and for nectar, and perhaps for pollen in some cases. Pollen grains have been found on the bill and feathers of the head of humming birds. These birds have been seen to frequent flowers of pelargoniums, fuchsias, trumpet-creepers, phloxes, verbenas, catmint, milkweed, tropæolums, honeysuckles, lilacs, morning-glories, cherry, wild balsams. I have no doubt they visit a great variety of other flowers which secrete honey in abundance. Mr. Osband visited trumpet-creepers, in flower, in bright days, and always saw birds. On one plant he saw eight birds at one time.

The pollen of fuchsias is sticky or in strings. Humming birds are the main visitors to the flowers. The calyx tube seems too long and narrow for most insects. Mr. Hollingsworth is very sure these birds visit the plant for nectar. Sometimes they pierce through the base of the calyx tube and take out the nectar. The student last named covered some flowers and found the stigmas were dusted with pollen without the aid of bees or birds. The ovaries also swelled as though forming seeds.

Mr. Wm. Snyder observed the fertilization of *Impatiens fulva*. The anthers form a covering over the pistil. He tied bags over young flower buds, also over flowers which had opened but before the stamens had disappeared. In both cases no good seeds were produced. Some he tied up and artificially crossed. The latter, without exception, matured fruit. In other cases he cut off all the petals of the flowers. He took down the signs. None of these set fruit. In other cases the nectar gland only was removed, with no fruit setting.

Sometimes he saw a large number of black bees at work, seemingly trying to get what exercise and nectar they could. They ran in and out many times, and hardly ever touched an anther or pistil. He could not see that the insects were of any use in fertilizing the flowers. Small wild bees behaved no better as far as carrying pollen was concerned. A common honey bee availed nothing in this direction. One humble bee hit pollen in

[1] Notes taken from papers of his young students by Prof. W. J. Beal.

his plunges to get at the nectar, but left the plant after trying a single flower. In frequent visits he often saw humming birds about the flowers going to all that were open at the time. Every time the birds thrust their beaks into the flowers, if the stamens had not yet been removed, the head, a little above the beak, would hit these and become dusted with pollen. Where the anthers had been removed the birds head left pollen on the stigmas. He saw, in one cluster, all the flowers visited twice in fifteen minutes. He is confident that *Impatiens fulva* is cross-fertilized mainly, if not wholly by humming birds.

Connection of the Rainfall with Forests.—According to a paper in *Polybiblion*, the following are the laws of meteorology as affected by forests:—1. It rains more abundantly, under identical circumstances, over forests than over non-wooded ground, and most abundantly over forests with trees in a green condition. 2. The degree of saturation of the air by moisture is greater above forests than over non-wooded ground, and much greater over masses of *Pinus sylvestris* than over masses of leaved species. 3. The leafage and branches of leafed trees intercept one-third, and those of resinous trees the half of the rainwater, which afterwards returns to the atmosphere by evaporation. On the other hand, these same leaves and branches restrain the evaporation of the water which reaches the ground, and that evaporation is nearly four times less under a mass of leafed forest than in the open, and two and one-third times only under a mass of pines. 4. The laws of the change of temperature out of and under wood are similar so those which result from the observations of M. Mathieu. The general conclusion seems to be that forests regulate the function of water, and exercise on the temperature, as on the atmosphere, an effect of "ponderation" and equilibrium.—*English Mechanic.*

The New Mexican Locust Tree, etc.—In the article on Colorado plants in the November number, on page 681, in the note on *Salix flavescens*, the word "hybrid" should read "form." It is apparent that no "hybrid" can occur unless both parents are found in the same vicinity, which in this instance is not the case. *Saxifraga chrysantha* from Pike's Peak is apparently the same as *S. serpyllifolia* of Porter and Coulter's Catalogue. *Artemesia arctica*, *Cnicus edulis* and *Troximon glaucum* are referred to, the last two under other names. *Robinia Neomexicana* is described therein also. E. L. Green, who first collected this species in Colorado, furnishes me with some interesting facts regarding it, which I take the liberty to quote from his letter. "The clump of trees to which you refer was found by me in 1873. It remains to-day the only known habitat of the species north of New Mexico, and strange to say, those trees are twice as large as any I ever saw in New Mexico; right on the banks of the river, and all around that clump of locusts grows *Bigelovia greenei*, which

no other botanist but myself has ever collected, although Drs. Hooker and Gray were over the same ground in 1877, and the plant is common along several of Dr. Parry's routes in New Mexico. The shrub at a distance, yes, even at the distance of a man's eyes from the ground at his feet, looks so much like *Gutierrezia euthamiæ* (which grows with it) that it must have been confounded with that plant by the numerous botanists who have crossed the vast tract of country which it inhabits."—*Isaac C. Martindale.*

INSECTS CAUGHT BY THE PHYSIANTHUS.—I am reminded, on reading the account of the manner in which insects are caught in the anther-wings of *Physianthus albens*, published in the last number of the AMERICAN NATURALIST, that I exhibited to the Boston Society of Natural History, Sept. 1, 1852, a specimen of that plant, and read a description of the manner in which insects became imprisoned in its anthers. The following passage is published in the report of my remarks: "The insects catch themselves, and so often does this occur that a gentleman in New York has obtained butterflies, bees and a great variety of other insects, enough to fill a large case, from the flowers of a plant growing in his garden."—*Chas. F. Sprague.*

We would also add that Prof. C. V. Riley, as he tells us, several years ago recorded in the Proceedings of the American Association for the Advancement of Science, the fact that he had found moths entrapped by the same plant.—*Editors.*

BOTANICAL NOTES.—The *Bulletin* of the Torrey Botanical Club, for November (received December 28th) contains farther notes on ballast plants near New York City, by Mr. A. Brown; and Prof. Eaton contributes the 7th of his articles on new and little-known ferns of the United States. The *Journal of Botany*, hitherto conducted by Mr. Henry Trimen will be edited by Mr. Brittain, during the absence of the former in Ceylon, as Director of the Botanical Gardens. This journal records the death of the following botanists: J. F. Von Brandt, a joint author with the late Dr. Ratzeburg, of the Medical Botany and Zoölogy; Carlo Bagnis, aged 24, and Professor of Botany in the new University of Rome; C. J. M. Von Klinggraff, author of a Flora of Prussia, and a memoir on the plant geography of Northern and Arctic Europe. ——*Grevillea* for December, notices Californian Sphæriæ, and prints an article on the propagation of *Sphæria fimbriata*, by C. B. Plowright.——The new part of Bentham and Hooker's Genera of Plants, will be issued in January, and will complete the Dicotyledonæ. The last part only remains to be published.—— Sir. J. D. Hooker has called attention to the discovery of a variety of the cedar of Lebanon on the mountains of Cyprus.

ZOÖLOGY.[1]

LEATHER TURTLE.—*Apropos* of the article on the "Leather Tortoise," in the October NATURALIST, perhaps the following may be of interest to the author.

A few years ago, in looking over the papers of Col. Richard Varick, the first mayor of the City of New York, in search of autographs and documents relating to the Revolutionary War, I came across a small circular, about six to seven inches in size, printed on the rough, unsized paper used by our forefathers, and of which the following is a copy of the subject matter:

"The dimensions of the *Testudo coriacea*, or leather tortoise, caught by Samuel Coon, one of the branch pilots of New York, on board the *Young Pilot*, by way of Sandy Hook, on the 27th Sept., 1811, and purchased by John Scudder, proprietor of the American Museum, No. 24 Chatham St., are as follows, taken under the eye of Dr. Mitchell, professor of natural history:

	Feet.	Inches.
Length from extremity of the snout to the end of the tail	7	6
Length of the buckler between the neck and tail	5	8
Girth of the body	8	0
Circumference of the buckler	13	2
" " neck	3	5
" of fore fin above the joint	2	5
" " " at the joint	2	8
Length of the fore fin	3	9½
" " head and neck from the buckler	1	7½
Distance between the extreme tips of the two fore fins	8	5
Breadth of the buckler	3	10½
Length of the hinder fin	2	1
Circumference of the hinder fin	2	4½
Distance between the extreme tips of the two hinder fins	5	5
Length of the tail	1	0
Circumference of the tail in the middle	1	5
Projection of the tail beyond the buckler	0	4
Width of the mouth across from corner to corner	0	10
Distance from the upper to the lower extremity of the jaws when the mouth was wide open	0	9½
Circumference of the eye-ball after extraction from the socket	0	5½

"His weight, when taken, was supposed to be rising 900 lbs., but from the loss of blood previous to his death, he weighed only 800 lbs."

This little circular, if thus it may be styled, is a very neat and modest one, and was, perhaps, printed by the proprietor of the museum to call attention to the specimen. You will perceive that this capture antedates the one you mention as having been made in Massachusetts bay by thirteen years.—*W. R. Gerard.*

THE CHIPPING VERSUS THE EUROPEAN SPARROW.—During the last two seasons the much dreaded European cabbage worm (*Pieris rapæ*) has been infesting the cabbage in this vicinity.

[1]The departments of Ornithology and Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

Several years earlier came that other pest, the European sparrow (*Passer domesticus*), and has pretty thoroughly driven away most of the other species of birds that are usually common about dwellings. On my own premises, instead of the cheerful music of the wren, robin and cat-bird, which formerly helped to make the surroundings attractive, I am compelled to be annoyed by miserable squeaks. This season a cabbage patch in my garden became thoroughly infested by the worms; I looked anxiously to see how thoroughly the European sparrow would do the work for which it has been transported over thousands of miles of land and water. But it was very seldom that any of the numerous individuals that have harbored about me for the past several years ever went near the patch; occasionally one of the young would fly down and take a worm, but I never saw a full-grown individual take one.

By accident I was observing the patch early in the morning, from day-break to a short time after sun-rise, when I chanced to find a number of chipping sparrows (*Spizella socialis* Bon.), taking worms as busily as possible. By continuing my observations I found this was the case every *morning* as long as the worms lasted; but during the rest of the day "chippy" was seldom seen in the patch. Whether this early feeding is the natural habit of this species, or whether it was not allowed to go about the premises during the rest of the day, I cannot say. But it did such efficient work that I feel it my duty to make it as widely known as possible.—*S. Schneck, M.D., Mt. Carmel, Ill.*

Depredations of the European Sparrow.—The following case, represented to me by Dr. A. K. Fisher, of Sing Sing, N. Y., substantiates one of the many charges brought against *Passer domesticus*.

"About a year ago I was interested in watching a sparrow pulling up peas in a neighbor's garden. The peas were up about an inch; the bird went along the row, taking the vines in his bill, placing his foot near the roots and pulling up the shoots and eating the peas. I saw him thus destroy several, when I stopped him by throwing a stone which unluckily missed him.

"The old saying that 'Birds of a feather flock together' is verified in the case of the sparrow's associates. The only bird which I have ever found which seemed to enjoy the company of the English sparrow, is that miserable form of bird life, the *Molothrus ater*. It would be difficut to find two more disreputable birds than this precious pair. Here they mix together a good deal, especially when the sparrows are a little way out of the village."—*Elliott Coues, Washington, D. C.*

On the Torpidity of Animals.—Some time in early December, 1878, when the snow first began to fly, a silver-haired bat, without a place to lie dormant in for the winter, flew into my hallway, about

nine in the evening, at Evanston, Ill. I was surprised at discovering a bat at that time of year, and secured it in a box. It was a bitter cold night and the bat hung himself up by its claws on the edge of the box among the cotton and went into a torpid state. Several days afterward I placed him over the fire and thawed him out. He became quite lively in the warmth, took a drop of water and flew around the room. The following night was the coldest of the season, and it again went into a torpid state and remained some two weeks in that condition before it was disturbed. My efforts to bring it to life on this occasion were not so successful as formerly. After much warming it came to sufficiently so that two spots of breath would appear on the mirror when held to it. In order to get a greater amount of heat to operate on it, I placed the box containing it on the fancy top of the stove, turned my back to it and became engaged in writing. I had written some time when my attention was aroused to a bad scent in the room. I turned around but to behold box and bat wrapped in flames. This ended my experiments in that direction, I had arrived at the following conclusions, however: That animals in a torpid state may be aroused by an application of heat; or, in other words, torpidity is but a state of lowered temperature of the body. I am strengthened in this conclusion by some observations of no little importance to the topic under consideration.

The torpidity of swallows has long been regarded as a tradition, but traditions are generally founded on fact, however perverted the facts may be. A young man, whose word I regard in all matters as perfectly trustworthy, told me that one April day while out gunning, he treed a coon. He borrowed an axe and as the tree was falling a half-bushel of swallows rolled out from the hollow. In the warm sun of the early spring day many of these took life, and consequently wings, and flew away. And why not!

Last winter the papers were prolific with stories about the resuscitation of sheep, cows, and even men, from a frozen state. Indeed, it is no secret of late years that the heat generated by a dog will easily bring to its natural state a frozen limb of a man. I noticed this fact in the South, the overflow of the Mississippi river leaves thousands of little ponds full of fishes, which in winter freeze up solidly. The fishes are confined in the ice. When these ponds thaw out, in spring, the fishes are liberated and go sporting about immediately. Fishes, of course, are cold-blooded and may not be affected by the ice. The fact remains, however, that during the winter a party of us were mapping the Mississippi, about Cairo, in Illinois, Kentucky, and Missouri, and that each day these fishes could be seen, frozen stiff, in the ice, many of which we cut out and examied, and from all appearances, were as dead as the logs that strewed the ground. But with the approach of warm weather, they were as lively as ever.

The only instance, in any way, against the above observations

occurred in the great Marshes of Lake Erie. During a severe winter the mud and water froze to a great depth. The consequence was that when the marshes thawed out the shallows were covered with dead turtles, snakes, frogs, etc. The unanimous opinion of the Corps of Engineers was, that the cause of this wholesale slaughter of the reptiles was some poison permeating the marshes, doubtless generated by the slow approach of spring. There may be such a thing as being frozen too effectually, however, for a good condition of torpidity. As a final instance I may note the return of frogs from their winter's quarters, at Camden, N. Y. Hundreds of these near this place came up from the earth in a shallow marsh, tumbling, leaping, and capering about, some of them appeared belly up, others with huge bags protruding from their mouths. They were all in a weak, half-sensible state, but gradually regained strength in the sunlight.

It is evident that animals do not assume a torpid state in warm weather, since no instance of the kind is known or recorded. The above instances seem therefore applicable to the previous conclusion that animals in a torpid state may be aroused by an increase of temperature, or in other words, torpidity is but a lowered temperature, sometimes to the freezing point.—*William Hosea Ballou.*

Migration of Dragon Flies.—On the 2d of June, in Weymouth, Mass., I observed what seemed to be a concerted migration of dragon flies, and should be glad to be informed whether such movements are of regular occurrence, and if they are, what is the explanation of them? I was sitting in a pasture near the edge of a wood (the wood being, perhaps, half a mile deep), at about eight o'clock in the morning, when I first became aware of what was going on. The flies came from over the trees, and generally on reaching the pasture, dropped to within five or ten feet of the ground, although many flew much higher and some went straight across the pasture at an estimated height of forty feet. All, with rare exceptions, kept a steady course due west, as though they were moving to some appointed rendezvous. They came in sight somewhat as waves come upon the beach—one minute there were none, and the next there were two or three or half a dozen together. I watched them for three hours or more, and in the afternoon followed in their train across two roads and some pasture lands to the edge of another wood. When they reached this wood they seemed, many of them, a little at a loss how to proceed, but soon mounted into the air and sailed over the trees out of sight. I then visited a small pond in the vicinity and took notice that they flew across it and kept on in their westerly course. As to the width of the column, I only know that it was at least a quarter of a mile. They were still flying at a little before eight o'clock in the evening, when it was almost too

dark to see them. The two following days were cold and stormy, but on the 5th a few were still straggling across the fields.

On the evening of the 23d inst., while crossing Boston Common, I saw what seemed to be a similar migration, and in this case also the course was west.—*Bradford Torrey.*

TRICHODINA PARASITIC ON THE GILLS OF NECTURUS.—I have to record a new habitat for this interesting ectoparasitic genus of Infusoria. I was recently searching the gill-filaments of a Necturus (which had died a few hours before in the attempt to swallow a young catfish) for specimens of a Polystome which I have described as occurring there, when I noticed the remains of a considerable number of Infusoria belonging to this genus. Only the aboral end of the body with its hooks and chitinous frame remained, the softer oral end being already disintegrated. I did not succeed in identifying it with *T. pediculus*, the ectoparasite of Hydra, which has been so admirably described by James-Clark (Mem. Bost. Soc. Nat. Hist., Vol. I, No. I), but it is possible that the examination of fresh specimens would prove it to belong to this species, which has also been indicated as occurring in the allantoid bladder of certain European newts (Busch, Müller's Archiv., 1855).

Since writing the above I have had the opportunity of examining a fresh Necturus with the result that its Vorticellidan parasite also occurs in the urinary bladder. It is identical with the Hydra parasite, *Trichodina pediculus*.—*R. Ramsay Wright, University College, Toronto.*

ZOÖLOGICAL NOTES.—The last number (3 of Vol. III, Part. I) of the Memoirs of the Boston Society of Natural History contains an elaborate essay, by S. H. Scudder, on the palæozoic cockroaches, being a complete revision of the species of both worlds, with an essay towards their classification. This work of 111 pages is illustrated by six excellent plates. It appears that the palæozoic cockroaches are, like many other groups of animals of the palæozoic age, old fashioned, obsolete forms which have been replaced by more modern types, and we may add that the existing cockroaches are to be congratulated that the shades of their ancestors have been thus recalled from their tombs and passed in review in a long and orderly procession.——Dr. Hagen is sanguine that noxious insects, such as the potato beetle, cotton worm and Rocky Mountain locust can be kept under, if not exterminated, by the use of yeast fungus; we hope that these fungi will take the place of Paris green as an insecticide, and trust another year to see experiments carried out upon an extensive scale; we know that myriads of insects, such as the house fly, are killed by fungi; why not myriads more, provided that the weather be sufficiently damp and warm for the growth of the fungus spores, a point not noticed by Dr. Hagen. In hot, dry

weather the fungus would probably not have a deadly effect.—— The attention of our readers has never been called to Baron Osten Sacken's second edition of the Catalogue of the described Diptera of North America, published about a year since by the Smithsonian Institution. It is invaluable as a work of reference. ——American students in foreign laboratories do work of as high an order as their German, French or English fellow students of the same schools. No better work in embryology has been done than that comprised in Mr. C. O. Whitman's essay on the embryology of the little leech, Clepsine. We now draw attention to the able paper of two recent Princeton graduates, Messrs. Scott and Osborn, who have worked up the early development of the common European newt, published in the Quarterly Journal of Microscopic Science for July last, and now issued in pamphlet form.

ANTHROPOLOGY.[1]

RAU'S PALENQUE TABLET..—The latest contribution to knowledge issued by the Smithsonian Institution, is No. 331 of its publications, a quarto of seventy-six pages, by Dr. Charles Rau, on the Palenque Tablet in the United States National Museum. The contents of the work are as follows: "Chapter I.—History of the Palenque Tablet; Chapter II.—Explorations of Palenque; Chapter III.—The Temple of the Cross; Chapter IV.—The Group of the Cross; Chapter V.—Aboriginal writing in Mexico, Yucatan and Central America; Appendix.—Notes on the Ruins of Yucatan and Central America." In the first chapter we have a minute relation of the manner in which the tablet found its way from the Temple of the Cross to its present position in the National Museum. In the second chapter Dr. Rau gives a narration of the various explorations of these interesting ruins. The name Palenque is derived from a village about eight miles away, called Santo Domingo del Palenque. The ruins were discovered in 1750, by a party of Spaniards, and surveyed for the first time by order of Ramon de Ordoñez in 1773–1784. The first exploration which lead to any result was that of Capt. Antonio del Rio in 1787; his manuscript was published in London, in 1822, with drawings from Castañeda, the artist of Dupaix. Capt. William Dupaix, in 1808, visited Palenque, with an artist named Castañeda. The MSS. and drawings will be found in Vols. IV, V, VI, of Kingsborough. Baron de Waldeck lived two years at Palenque making surveys and sketches, 1832–4. His plates, with text by De Bourbourg, was published in Paris, in 1866, by the French Government.

When Dupaix visited Palenque the three slabs constituting the Group of the Cross were all in place. But at the time of Waldeck's visit, the right one, now called the Smithsonian Tablet,

[1]Edited by Prof. OTIS T. MASON, Columbian College, Washington, D. C.

was in fragments on the floor; the middle one had been carried off to the banks of the river by a vandal who wished to adorn his house with it; and the one on the left was in its original position, which it now occupies. Stephens and Catherwood visited the spot in 1840, and were entertained by Mr. Charles Russel, our counsel at Laguna. They made drawings of the ruins, and shortly after their visit the fragments of the right hand slab were sent to the National Institute in Washington, where it arrived in 1842. The site has since been visited by Arthur Morelet in 1846, and M. Désiré Charnay, for the French Government, in 1857. The tablet was transferred to the Smithsonian Institution 1858, and in 1863, while making a cast for Prof. Henry, Dr. George A. Matile discovered that this was the missing slab from the Palenque group, not drawn by explorers after Dupaix. It was broken again after Dr. Matile's cast was made, but reconstructed and set in its present frame, from which Dr. Rau's photograph was taken. Whatever doubt may have remained after Matile's argument, is now dispelled by reference to the outline plate of Dr. Rau's work, in which the whole Group of the Cross is again restored.

The occurrence of the sign of the cross in America anterior to its discovery by Columbus, has been the marvel of archæologists. But the fact of its appearance in many places where Christian influence had never been felt, compelled the student to look for other motives in its existence. The whole subject is reviewed in Chapter IV, pp. 39–46. Of equal interest with the allegorical sculpture is the subjects of the hieroglyphics, on which Dr. Rau has bestowed a great deal of faithful study. The supposed key to their interpretation is a MSS. found in the Royal Library of Madrid, by Brasseur de Bourbourg, in 1863, which is a copy of one composed by Diego de Landa, in 1579, and giving, among other things, an alphabet of thirty-three signs. It will be remembered that a similar old MSS. is mentioned by Sr. Orozcoy Berra, in Anales del Museo Nacional de Mexico, containing the Lord's Prayer in symbols, partly Aztec and partly ecclesiastic. All attempts to interpret the Central American glyphs and manuscripts by Landa's alphabet have proved failures. Dr. Rau, the most cautious of theorists, does not attempt a solution; but on page 61 gives a diagram of his outline plate, by which every glyph on the tablet may be easily referred to (it is a pity that the letters and figures do not occur on the margin of the plate itself). On pages 62 and 63, some of the glyphs are analyzed, and the places where the elements are to be found, are indicated. The author concludes that the analogies between Landa's signs and the glyphs warrant the suggestion that the inscriptions constitute a chronological record of some kind. On pages 53 and 64 Dr. Rau corrects an error of Humboldt, Kingsborough, Stephens, and others, as to the close relationship between the

Aztecs and ancient Mayas based on the Dresden Codex, which is clearly shown to be of Maya and not of Mexican origin at all.

On page 75 the author reaffirms the view of Stephens, Bancroft, as well as his own, "that the Yucatan structures were built by the Mayas, the direct ancestors of the people found on the peninsula at the Conquest, and of the present native population."

ANTHROPOLOGICAL NEWS.—Mr. H. R. Howland is the author of a brochure entitled "Primitive Arts and Modes of Life," the substance of which was read before the Buffalo Society of Natural Sciences, March 15, 1879. The object of the author is to show how, in simple beginnings, out of the dire needs of humanity, have been born the arts of life as known to civilized man; how with patient toil he has wrought out, by means God-given, the problem of his growth and their advancement.

A printed notice of four pages, announces the formation, in Boston, of the "Archæological Institute of America," for the purpose of promoting and directing archæological investigation and research, by sending out expeditions for special researches, by aiding the efforts of independent explorers, by publication of reports of the results of expeditions which the institute may undertake or promote, and by any other means which may from time to time appear practicable. The institute consists of life members contributing at one time $100, and of annual members paying $10 per annum. Membership is now open to all persons interested in the objects of the institute, and who may desire to join it. The call is signed by Francis Parkman, W. W. Goodwin, Alexander Agassiz and other distinguished scholars. Prof. C. E. Norton is president, and Mr. Edward H. Greenleaf, Museum of Fine Arts, Boston, Mass., secretary, to whom all communications should be addressed.

"The Aboriginal Soapstone Quarries in the District of Columbia" is the title of a brochure from the Twelfth Annual Report of the Peabody Museum of Archæology and Ethnology, by Elmer R. Reynolds. The discovery of the soapstone quarry at Chulu, Amelia county, Virginia, seems to have kindled a great deal of enthusiasm in our archæologists with reference to aboriginal quarrying and mining. Dr. Reynolds is an indefatigable hunter, and his success in discovering soapstone quarries in the District of Columbia, almost under the shadow of the National Museum, is graphically described in the pamphlet before us.

The Society of Biblical Archæology has for its object the study of the languages, remains and natural history of those lands with which the Jews were associated, from the earliest times to the close of the canon of Scriptures, with a view to the better understanding of the Old and New Testament. In point of fact the history of the Jewish race demands an intimate acquaintance with the civilizations of the Nile valley, Mesopotamia, the slopes of the Lebanon range, and, in latest Biblical times, of that of Greece

and Rome. The society has for its president Dr. Samuel Birch, the Egyptologist, and includes many of the most distinguished men in England among its members. The honorable secretary for foreign correspondence is the Rev. A. H. Sayce. An acquaintance with its publications is indispensable to those who wish to pursue the study of Oriental archæology.

The first number of Vol. IX of "The Journal of the Anthropological Institute of Great Britain and Ireland, August, 1879," contains the following papers: Exhibition of the cranium of a Native of one of Fiji islands, by Prof. Flower; The Primitive Human Family, by C. Staniland Wake; On an *Echelle de Couleurs*, published by the Société Sténochromique of Paris, by E. W. Brabrook; Remarks on the Geographical Distribution of Games, by Edward B. Tylor; On some Rock Carvings found in the neighborhood of Sydney, by Sir Charles Nicholson; Relationships and the names used for them among the peoples of Madagascar, chiefly the Hovas, together with observations upon marriage customs and morals among the Malagasy, by the Rev. James Sebree, Jr.; History of the South-western Barbarians and Chaou-Seën, translated from the "Tseen Han Shoo," book 95, by A. Wylie, Esq.; Rag-Bushes and kindred observances, by M. J. Walhouse (See "Fetish or Rag-Bushes in Madagascar," *Saturday Magazine*, Nov. 22).

Mr. Wake's paper is a continuation of the author's discussion of a kindred subject in Vol. VIII, of the *Journal*. After reviewing Mr. McLennan's theory of the origin of society in polyandry, he adds, "We cannot suppose that the primeval group of mankind consisted only of a woman and her children; and if the woman had a male companion, we cannot doubt, judging from what we know of savage races, that he would be the head and chief of the group. * * * Self interest chiefly would govern the father in connection with the marriage of his daughter. Whether the marriage was to be a permanent or a terminable engagement, he would stipulate that they should continue to live with or near him, and that her children should belong to him as the head of the family group. In this case, not only would the children form part of the family to which their mother belonged, but the husband himself would become united to it, and would be required to labor for the benefit of his father-in-law. When the wife left her father's house to reside with her husband, he had to purchase the privilege by giving her father and other relatives handsome presents. [This could hardly have occurred at first, when property was not held in severalty. It marks a higher step in culture]. In this case the children belonged to their father's family, and the fact of the wife going to reside among her husband's relatives meant the loss of the children by *her* father's family. The presents may, therefore, be supposed to represent the price given by a man for his wife's offspring to her relatives. Probably the wide-spread

custom of pretended forcible marriage was originally thus connected with the rights of the woman's relatives, and may have originated in the desire to obtain for nothing what could otherwise be acquired only by a purchase fee.

These rights, according to Morgan, are inheritance of the property of deceased members, reciprocal obligations of help, defence, and redress of injuries, and the obligation not to marry in the *gens*, although practically, the property was appropriated by the nearest of kin. Morgan says nothing of any right of the gens over the marriage of its members, and it would seem not to have had any voice in the matter. Reference to the custom of blood-revenge confirms the view that, for certain purposes, a smaller family group than the *gens* is recognized by the people having that organization. The example of the Polynesians, who are said not to have arisen to the conception of the gens, shows that before this was developed, not only was the *lex talionis* recognized, but the law of marriage and the rights of parents over their children were fully established. It is evident, therefore, that the primitive family cannot have originated with the gens, or clan; on the contrary, the clan was based on the family or group of kinsmen, which would be a parent, his wife or wives; their daughters, together with the husband and children of the latter.

The view of the ancient family held by De Coulange and Sir Henry Maine would be complete if it provided for the fact, that descent was originally traced by the female line in preference to the male line. The defect thus revealed will be removed if it can be shown that descent through the male is for certain purposes recognized equally with that through the female." Mr. Wake, in closing, draws attention to the important fact first noticed by Mr. Fiske, that owing to the prolongation of infancy children had to be nurtured by female parents aided by males to some extent; and to Mr. Spencer's remark that, "To the yearnings of natural affection are added in the early stages of progress, certain motives, partly personal, partly social, which help to secure the lives of children; but which, at the same time initiate differences of status between children of different sexes. There is the desire to strengthen the tribe in war; there is the wish to have a future avenger on individual enemies; there is the anxiety to leave behind one who will perform the funeral rites." Under the influence of these various ideas and circumstances, the custom of tracing kinship for certain purposes in the female line would be developed by the time that the habit had been formed of wives leaving their parents to reside among the husband's family. When this took place the custom would be fully established under the influence of polygamy, and the development of the gentile organization would almost necessarily follow. The primitive idea of kinship through the father would, however, still remain in full force with the attributes which originally appertained to it,

namely, the headship in the family group of the oldest male ancestor, whose authority is practically represented by the tribe, and the non-intermarriage of those thus connected.

GEOLOGY AND PALÆONTOLOGY.

THE WATER SHEDS OF THE STATE OF NEW YORK.—The State of New York presents two of the most remarkable water-sheds on the North American continent, if not on the face of the globe. Though situated so near one another that their extremities may be said to almost interlock, they are widely different in their physical features and distribution of water supply. One has been made the mighty servant of man and is harnessed for his bidding, while the other bids defiance, gushing forth its waters at its will, sometimes flooding a vast area of territory, and again leaving its river-beds to dry in the sun.

The most powerful of these is drained by the Oswego river. Its area contains no less than seven thousand square miles of territory. It comprises the well-known chain of lakes, some of which are of considerable size and importance—the Oneida, Cayuga, Seneca, etc., amounting to over four hundred square miles of lake surface. Besides being in themselves natural reservoirs, the State has further improved Seneca lake so as to regulate the periodical flow of the water. The average flow of the water is thus secured at about 600,000 cubic feet per minute. Twenty miles above the mouth of the Oswego river is Three River Point. From this place, down stream, there is a fall of water amounting to seventy-five feet. This space is taken up by seven dams erected and maintained by the State. Of these, two are situated at Oswego, covering a fall of forty feet. These dams accord hydraulic privileges equal to 25,000 horse power. But a moderate outlay is required to keep the flow in the river near the average for the year. 75,000 cubic feet of this water supply are in actual use in Oswego, where a canal is provided for the reception which furnishes fifty runs of first class water and over seventeen of the second class.

Two dams are situated at Fulton with 20,000 horse power. At this point the water privileges are easiest available, although Oswego has the greater representation of industries.

The Oswego River water shed produces clear cold water, which is perfectly under control of man, no matter what the circumstances or exigences. The river bank forms a line teeming with industries, with millions of dollars of money invested. This water supply never endangers the lives of citizens or encroaches on their property, but on the contrary, affords a roadway for inland navigation through the canals which it feeds.

Not so the other subject of this paper. Situated on the highest point in New York, among the Adirondacks, it submits to no governmental check, but ejects its turbid waters, dashing down

athwart and over precipices, which in spring time bear before them bridges and valuable property, not to say the lives of mankind.

This water shed covers an arça of 2000 square miles. It comprises not less than five hundred little lakes and lakelets, some of which are said to be as large as Cayuga. 4326 feet above the sea level a little lake known as "Tear of the Clouds" starts the Hudson marching onward to the sea.

Here also rise the Moose, Beaver, Oswegatchie, Gross, Raquette, St. Regis, Salmon, Au Sable, Bouquet rivers and many other streams. Could the streams have a uniform flow during the year, the volume of water emitted would be enormous for economic use. But though violent in time of flood they are quite low, not to say often nearly dry, in summer time.

Strange as it may seem, these rivers are scarcely of use as bearing rich deposits for the low land, like the Mississippi, Missouri, etc. The region from whence they emanate is peculiarly hostile to cultivation, and has resented all attempts at settlement and immigration, and gives no return for the careful sowing of seed.

The waters afford few privileges of navigation to the hewer of timber or the excavator of ores in the mountains. They form, however, the fishing ground of America, and yield an abundance of the best of the finny tribe. Its mission in futurity is now foretold as the solving of the problem of water supply to fifty millions of people who may possibly inhabit the Mohawk valley. For the present it is to gratify the pleasurable longings of mankind. The Empire State has, therefore, two grand water sheds, the one for the accumulation of untold wealth and the other for its dissipation. But what is an Empire without unlimited resources?—*W. H. Ballou.*[1]

Geological Survey of New Zealand.—Dr. Hector's Progress Report for 1878-9, contains a synopsis of the classification of the formations of New Zealand, of which we present a summary: 1. Post-tertiary, including Moa beds, Alluvia and Raised beaches, Moraines, etc. 2. Pliocene, 1500 feet, with three divisions, Terrace plains, Pumice sands and Lignites, Kereru Rotella beds, etc. 3. Upper Miocene, 500 to 1000 feet, including Wanganani beds, Manawatu gorge, Castlepoint, Toerua and Ross, and Waitotara and Awatere beds. In this formation 125 species of Mollusca have been found, of which 120 are found in the existing seas. 4. Lower Miocene, 1000 to 1500 feet, containing 110 extinct marine forms and 55 existing species; divisions two, Mangapokeha valley and the Taipo Awainoa and Pareora beds. 5. Upper Eocene, 500 to 700 feet, with three divisions, Mount

[1] I acknowledge the valuable assistance of Mr. Chas. Rhodes, a noted lawyer of Oswego, and Prof. Calvin, of the State Survey, in the preparation of this article.

Brown beds, Hutchinson's Quarry beds and Nummulitic beds. Intense volcanic activity prevailed during this period in both islands, and the calcareous strata are frequently interbedded with contemporaneous igneous rocks and tufas, and in the North Island are often replaced by wide-spread trachyte flöes and volcanic breccias. 6. Cretaceo-tertiary, 2000 to 5000 feet, with seven divisions, Gray marls, Ototara and Weka Pass stone, Fucoidal greensands, Amuri limestone, Chalk marls and chalk with flints, Marly greensands, Island sandstone (Reptilian beds) and black grit and coal formation. The marine fossils include, besides well-marked greensand forms such as *Ancyloceras*, *Belemnites* and *Rostellaria*, a number that have still a marked affinity to the Tertiary fauna. Saurian bones occur of the genera *Plesiosaurus*, *Mauisaurus*, *Liodon*, &c., in this part of the formation; but they have only been found as yet over a limited area on the east side of the South Island. 7. Lower Greensand, 500 feet, with two divisions, Amuri group on east coast, Bituminous coals on west coast. 8. Jurassic, 3000 to 5000 feet, with three divisions, Mataura series, Putataka series, and Flag Hill series. The Flag Hill series, which is principally developed in the Hokanui range, Southland, contains fossil plants in its upper beds, which are especially interesting, from at least one species being identical with a plant found in the Ramahal beds of India, which are considered to be of Liassic age, viz: *Macrotæniopteris lata*, with which several others are associated, six of which have been identified. 9. Lias, 2000 feet, with one division, Catlin's river and Bastion series. 10. Trias, 5000 to 8000 feet, with three divisions, Otapiri series, Wairoa series and Oreti series. The Otapiri series is remarkable for the mixed character of its fossils, which, however, contain many forms identical with those from the Rhætic formation of the European Alps. The fossils are chiefly Permian and Triassic forms, but a *Pentacrinus* also occurs, which resembles the Jurassic species. 11. Permian, 6600 to 7000 with one division, the Kaihiku series. 12. Lower Carboniferous and Upper Devonian, 7000 to 10,000 feet, with two divisions, Maitai series and Te Anau series. 13. Lower Devonian, 5000 feet, with one division, the Reefton beds. 14. Upper Silurian, 3000 feet, with the Baton River series. 15. Lower Silurian, 7000 to 10,000, with one division, Mount Arthur series. Below this horizon the quartzite and gneissic granite are found in the mountain ranges.

Hill's Kansas Explorations.—During the past year Russell S. Hill, of Philadelphia, continued his explorations of the Loup Fork formation of Kansas and Nebraska. He obtained fine specimens of the large mammals discovered last year, especially of *Mastodon campester* and *Aphelops fossiger*, and added representatives of groups not previously known from this horizon. He discovered the pharyngeal bones of Cyprinid fishes, probably of the genus *Alburnops*, also salamanders and *Anura*. There are also

Lacertilia and snakes, some of the latter *Crotalidæ*, as indicated by the characteristic maxillary bone, with its teeth. Specimens of *Procerulus furcatus* with a burr on the horn, show that this species did not differ from *P. necatus* in this respect; also that the *P. ramosus* is distinct from it as a species. In Nebraska Mr. Hill found the Ticholeptus beds containing *Leptauchenia*, etc., occupying the place between the White River and Loup Fork formations already assigned them.

Hulke on Ornithopsis of Seeley.—In the last Quarterly Journal of the Geological Society for 1879, Dr. J. W. Hulke discusses the characters of the huge Saurian named *Ornithopsis hulkei* by Seeley. He identifies with it the *Chondrosteosaurus* of Owen and the *Eucamerotus* of Hulke, but regards the American *Camarasaurus* as distinct. He figures a centrum remarkable for the extent of its lateral excavations, and of more elongate form than the corresponding ones of *Camarasaurus*. He points out the existence of the hyposphen in *Cetiosaurus oxoniensis* and in *Megalosaurus* as figured by Phillips, using for it the term zygosphen, which is, however, homologically a different structure.

Filhol on the Fauna of St. Gerand le Puy.—The region of the Allier, Puy de Dome and Haut Loire, has for years furnished beautiful specimens of extinct vertebrates to the geologists of France, beginning with the time of Cuvier and De Blainville. Dr. Filhol has recently reviewed the work hitherto done in this field, and with the aid of much new material, which includes that obtained by Dr. Alphonse Milne Edwards, has commenced the publication of a detailed monograph. The first part, issued in the Annales des Sciences Geologiques, contains descriptions and figures of three species of *Chiroptera*, one of *Insectivora*, four of *Rodentia*, twenty-six of *Carnivora*, and five of *Artiodactyla*. The elucidation of this fauna is of interest to American palæontologists, since it corresponds approximately in time with the Truckee or Oregon division of our White River fauna. The faunal differences are as numerous as the resemblances. In France *Canidæ* abound, but they are mostly *Amphicyons*, not *Canis* nor other genera found in Oregon. Weasels are much more numerous than in America. There is a near affinity between Filhol's genus *Proælurus* and our *Archælurus*, though the two are distinct. Other forms of *Felidæ* are not recorded. The *Artiodactyla* are *Cænotheria*, which are abundant in species and individuals. The fullness of M. Filhol's descriptions makes them of much value to science, and the light he throws on questions of synonymy is an important acquisition. We can only wish that he could consult euphony more frequently in the construction of new generic names.

Notes on Sabre-tooths.—The large species described in the December number of this Journal as *Hoplophoneus platycopis* turns out to belong to a new genus, which has a premolar tooth addi-

tional to the number usual in sabre-tooths. It agrees with *Dinictis* in this respect, and in its formula Pm. $\frac{3}{3}$, M. $\frac{1}{1}$, with that I assigned to *Daptophilus*. The latter however appears to have been based on an immature *Dinictis*. The new genus may be called *Pogonodon*.

Nearly the smallest of the Oregon sabre-tooths is probably undescribed. It is represented by the greater part of a skull with parts of all the teeth of one side. Its brain case is relatively large, and the sagittal crest small; the occiput is wide and vertical. Post-orbital process robust and prominent; mastoid and glenoid processes elongate. There is but one, a small premolar in front of the sectorial, and it has a very prominent heel. The sectorial has a prominent anterior lobe, showing that the species is probably a true *Machærodus*. The tubercular is very small. The canines are relatively very large; their crowns are not preserved. The front is slightly protuberant on each side of the middle line and then descends steeply to the orbit; sagittal crest horizontal. Length of cranium (axial) M. 0.120; from muzzle to orbit .045; vertical diameter of orbit .025. Long diameter of canine .015; length of diastema .011; of premolar .006; of sectorial .015; width between posterior external angles of sectorials .056. The species may be called *Machærodus cerebralis*.—*E. D. Cope.*

GEOGRAPHY AND TRAVELS.[1]

African Exploration.—The *Henry Venn*, a steamer belonging to the English Church Missionary Society, started from Lukoja, at the mouth of the Benué, on July 8, 1879, to ascend that stream as far as practicable.——The *Academy* notices a two years' exploration of the river Gambia, made by Mr. Frederic Speer, in the course of which he penetrated higher up the stream than any European had ever done before. Though unable to take observations, he has taken compass bearings and laid down the upper course of the stream with considerable accuracy. He thinks British traders would be able without much difficulty to establish a valuable trade with Timbuktu and the upper Niger. A similar report is made from the upper Volta, which was visited recently by M. Buss, a missionary, who met with a friendly reception at Salaga, the chief town of that region, containing about 50,000 inhabitants.——Herr Schütt, whose explorations in Central Africa were noticed in our number for May, 1879, has returned to Europe with large natural history collections and carefully drawn maps of the region traversed by him, which included a large tract of hitherto unknown country between the Kwango and the Kassai rivers, or between about 18° and 22° E. longitude, part of which is under the rule of the famous Mwata Yanvo. He has made some important discoveries concerning the intricate hydro-

[1] Edited by Ellis H. Yarnall, Philadelphia.

graphy of the Congo water shed. He met with four tributaries to that river lying between the Kwango and the Kassai, viz., the Kwango, Marata, Cinlu and the Kwanger rivers. He has laid down the Kassai from 8° S. lat., to about 6° S. lat., but was stopped by king Mai, when within two days of the great waterfalls on that stream. The Kassai is known as the Zaire from 8° S. as far as 4° S. Mucarouba is the native name for the lake heretofore called Sankowa, and it is situated in about lat. 5° S. A tribe of dwarfs live near it.——The former companions of Maj. Serpa Pinto, Messrs. Ivens and Capello when last heard from were in the district called Duque de Braganza, unable to proceed further in their attempt to trace the Kwango down to its junction with the Congo for want of means. The Portuguese government has been asked to aid them.——A mission station has been established by a French priest, Pere Duparquet, in Ovampoland, a tract of country south of the river Cunene, between 14° and 18° E. long.——Dr. Emil Holub has recently returned to Europe after seven years passed in Southern Africa. Born in Bohemia in 1847, he very early manifested great interest in natural history and geography and especially in African exploration. After receiving the degree of M. D. at Prague, in 1872, he started for Africa with a total capital of £53. He succeeded in reaching the South African diamond-fields and supported himself and earned sufficient to pay the expenses of his three journeys by his medical practice there. He has explored the country north and south of the Zambesi and studied the habits of the Matabele, the Marutsi, Hottentots, Bechuanas and numerous other tribes, living among them as their guest, and gaining their confidence by curing their sick. His last journey was the most important, lasting for twenty-one months, during which he accurately surveyed the country from the Diamond fields to the Zambesi, and the Zambesi from its junction with the Chobe to the Barotse country.

His map of the Zambesi is on a large scale, showing every island, creek and rapid. "To show the difficulties of this survey it may be mentioned," says a writer in the London *Times*, "that owing to the loss of his Nautical Almanac his sextant was useless and the bearings had to be taken by compass observations every three hundred yards, while the distances amounting in the various surveys to over 2,000 miles, were determined by *stepping*. That is the explorer counted every step he took during a twenty-one month's walk. He arrived at Muchela Amsinga tired and unwell, but still full of pluck and hoping to cross the continent and emerge at Loanda. Then fever came on and his best canoe containing all his gunpowder and, worse than all, his quinine, sank in a rapid. He still pushed on, but at the Naverbine cataract he succumbed, and was carried back insensible by his native servants to lie ill during a period of sixteen months."

On arriving at Cape Town on his return, he was most warmly

received by the governor and the public. He has also received a medal from the Vienna Geographical Society, and many distinguished honors since reaching his native land. In an interesting notice published in the *Athenæum* (October 4, 1879,) Col. Yultes states that Dr. Holub has brought with him, besides a few surviving animals, forty-nine cases of collections containing minerals, fossils, botanical preparations, and herbaria, seeds and fruits, fishes, bird-skins, nests and eggs, reptiles and insects, including some thousands of beetles, horns and skins of mammals, anatomical preparations, a large collection of ethnographic objects and a number of the famous "Bushmen engravings" on stone, etc. There are, besides in Prague, fifty-six cases containing the fruits of the earlier journeys. There are also extensive topographical sketches, several hundred drawings of botanical, zoölogical and ethnological interest. Dr. Holub hopes to obtain funds in Europe to form an international expedition of twelve members from as many different nations for the special purpose of opening Central Africa towards the south and east, and to facilitate the colonization of the district between the Vaal river and the Zambesi.——The Royal Geographical Society has received a letter from Mr. Thomson in command of the expedition to Lake Nyassa dated August 30th, at Mkubwasanya, in Uhéhé, a tract of country north of the Kondi mountains, at an elevation of 6000 or 7000 feet above the sea and about six days' journey from Lake Nyassa. ——The London Missionary Society has lost another of its members by death at Ujiji, the Rev. A. W. Dodgshun. The company which left Zanzibar under the leadership of the late Dr. Mullens, had reached Mirambo's capital, in Unyamwezi, at last accounts going from Mpwapwa by a new and unexplored route.——The Portuguese authorities are contemplating the construction of a road from Quillimane to Lake Nyassa.——The Indian elephants sent out by the King of the Belgians have reached Mpwapwa; all in good health except one which died shortly after arriving there. Each elephant carried about ten hundred-weight. In the district where the tsetze flies abound the animals were often covered by them without feeling any the worse for it. They are expected to be used at first for catching and training African elephants.——The Portuguese are about establishing a colony at Zumbo, fifty miles from Tete, and the government has made extensive grants to the company formed for that purpose.——The first Belgian expedition was expected to reach Tanganyika towards the end of June last. M. Cambier has been instructed to push on to Nyangwe on the Congo. His party ultimately expected to enter into Lunda or Ulunda west of the Congo, and are to be furnished with supplies from the expedition now under command of Mr. H. M. Stanley.

The second expedition under M. Popelin has been directed to establish its station on the eastern shore of Lake Tanganyika, in a bay some little distance south of Ujiji. This company reached

Mpwapwa on August 15th last, and expected to commence the journey across Ugogo on September 3rd. Mr. Stanley left Sierra Leone on September 3rd, for Banana (Banza?) on the Congo.——According to the *Academy* King Mtsesa has recently showed himself less friendly to the Missionaries of the English Church Mission, accusing them of complicity with the Egyptians. The Missionaries have been reinforced by the arrival of three more by way of the Nile via Magungo and the Albert Nyanza, and of two others by the lake from Kagei at the southern extremity.——Menelek, king of Shoa, has written to the Geographical Society of Paris urging the sending out of a French Mission, promising to employ all his power on their behalf. The Sultan of Somali land, on the western coast of the Gulf of Aden, has also invited foreigners to visit his dominions.——Gessi Pacha has succeeded in capturing the last refuge of the slave traders in the Soudan. Over 4000 have been expelled from the country and twenty-five slave caravans of between three and four hundred slaves each have been captured. ——Dr. Wilhelm Junker has returned recently to Europe after three years spent in explorations on the upper Nile. Dr. Schweinfurth writes to the *Athenæum* (August 23, 1879,) giving an account of his travels, illustrated by a small map of the Welle basin. Dr. Junker has brought back with him and given to the Russian Academy of Sciences the largest and best ethnological collection yet obtained in these regions. His careful surveys throw a flood of light upon the water shed separating the Nile from the Welle, and present a basis for mapping an area of four square degrees. He has also made a survey of the lower Sobat. The results of his investigations in the district lying between the Welle river and the Bahrel Ghazel are given in much detail, and the corrections necessary in Schweinfurth's own itinerary indicated. Dr. Junker reached his furthest point in lat. 20° 30′ N., where at a distance of twenty miles he saw a range of high mountains identified by him as the Blue mountains of Baker to the west of the Albert Nyanza.

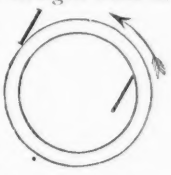
MICROSCOPY.[1]

Thin Glass Slide Troughs.—These are made of glass slips, three inches by one and one-third inches, to which are cemented slips of thin glass two inches by one inch, out of which a semicircle of three-quarters of an inch radius has been cut, and then covered with another thin glass two inches by one inch. It is well to have an assortment of these, of different thicknesses or depths, and for those of greater depths it is more convenient to make the distance-plates of vulcanite instead of glass. These troughs should always be washed out directly after use.

Preparations of Crystals for the Polariscope.—After preparing crystals, dry, in Canada balsam, and in castor oil, it

[1] This department is edited by Dr. R. H. Ward, Troy, N. Y.

occurred to me to attempt to preserve them in their own mother liquor. To do this paint on a slide a thin ring of gold size, whose entire diameter shall equal that of the cover glass. To make the edges of the ring smooth and true hold the flat edge of a small chisel against them at the points indicated by the straight lines in the figure, whirling the turn-table in the direction indicated by the arrow. As soon as the ring is finished heat it over the flame of a lamp until it becomes brown. Put into a test tube a little salycine, tartaric acid, prussiate of potash, or other substance adapted for examination with the polariscope, add water and apply heat until the solution is of such strength that crystals will form in it only when quite cold. Coat the ring, already hardened, with a little fresh size, and likewise the edge of the cover glass. Put the slide and cover glass thus prepared, on the hot plate for a few minutes and then pour a few drops of the boiling solution from the test tube into the cell and apply the cover glass, immediately pressing it down gently with a dry cloth which will absorb the superfluous liquid. Touch the edge of the cover glass with gold size and then transfer to the turn-table and finish. If the above directions have been followed correctly the cell will contain a clear liquid which begins to deposit crystals as it cools. Transfer the slide to the stage of the microscope soon enough to watch this process. Without the aid of the polariscope it is of interest, but with that accessory the spectacle presented is exceedingly beautiful.



After standing for some time however, the crystals appear to lose their sharpness and perfection of form. They may be restored by a fresh application of heat sufficient to cause them to dissolve and enter upon new forms of combination. As a means of observing the process of crystallization this method appears to be the best, and many of the results as respects brilliancy of color and perfection of outline are unsurpassed. I would recommend however, that those who have not tried it, should make a moderately strong solution of salycine or tartaric acid in boiling water and pour it over a warmed slide, draining off the greater part immediately. When crystallization ceases put a drop of Canada balsam in the center of the slide and apply a cover glass. Examine, and if found satisfactory, harden the balsam and finish in the usual way. Having once learned these processes, there is no limit to the range of experiments that may be made. For instance, a strong solution of santonine in chloroform gives very fine crystals which are quite permanent and brilliant when mounted dry. It should be noted that the quantity and strength of the solution employed will modify the results obtained, also agitation of the fluid whilst evaporating will in some instances introduce crystals of an entirely different form from those obtained when it is permitted to remain undisturbed.—*M. A. Verder.*

SEPARATING FORAMINIFERA FROM SAND.—If you throw dried sponge sand into water, slowly, all the foraminifers will sink, and sand will float on the water. A slide dipped under the floating film of grains will bring up only sand. You can safely skim off and throw away all that does not sink with a little stirring. Then the sunken part should be dipped out, about a dessert-spoonful at a time, into a small saucer, and water enough to just fairly cover them put in, and all floating grains stirred down. Then by a circling movement of the hand the foraminifers will be got to the top, and by gradually tipping the saucer and slowing up the movement they can be worked to one edge of the little pile of sand, and thence carefully dipped up with a rubber bulb pipette. In this way they are got almost pure. Only a little sand must be washed at a time, or not all the foraminifers will be got out, and very little water must be used or sand will get mixed with them. Much water moves the light sand, but a shallow wave seems not to stir it, but yet rolls the shells along—*C. M. Vorce.*

NATURALISTS' DIRECTORY.—The Naturalists' Directory for 1879, recently published by S. E. Cassino, at Salem, Mass., contains by far the best register of American microscopists yet published. It will be found especially useful to the microscopists who desire to arrange for exchanges in different parts of the country.

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SCIENTIFIC NEWS.

— Recent arrivals at Zoölogical Garden, of Philadelphia: 1 sandhill crane (*Grus americana*); 2 cheetahs (*Felis jubata*) ♂ ♀ Africa; 1 sun bear (*Helarctos euryspilus*) Borneo; 1 Chacma baboon (*Cynocephalus porcarius*); 2 electrical eels (*Gymnotus electricus*) and 2 red-crested cardinals (*Paroaria cucullata*) South America; 3 mule deer (*Cervus macrotis*) and 1 fallow deer (*Dama vulgaris*) Europe, bred in the garden; 7 mandarin ducks (*Aix galericulata*), China; 1 rose-crested cockatoo (*Cacatua moluccensis*); 78 finches, of the following species: *Amadina fasciata, A. bicolor, Munia undulata, M. maja, M. acuticauda, M. malacca, Estrelda amandava* and *E. melpoda;* 2 American elk (*Cervus canadensis*) and 2 Virginia deer (*Cervus virginianus*), bred in the garden; 1 Marabou stork (*Leptoptilus crumeniferus*), West Africa; 2 black-tailed parrakeets (*Polytelis melanurus*), Australia; 1 grand galago (*Galago crassicaudata*), East Africa; 1 Ducorps cockatoo (*Cacatua ducorpsi*), Solomon Islands; 1 lesser sulphur-crested cockatoo (*Cacatua sulphurea*), Moluccas; 1 white goshawk (*Astur novæ-hollandiæ*, Australia; 2 hyacinthine porphyrios (*Porphyrio hyacinthinus*) Europe; 2 white storks (*Ciconia alba*), Germany; 1 armadillo (*Dasypus novem-cinctus*), Texas; 4 collared peccaries (*Dicotyles torquatus*); 5 woodchucks (*Arctomys monax*) and 27 com-

mon opossums (*Didelphys virginianus*), bred in the garden; 32 *Amblystoma mavortium* and 10 of the siredon form of that species from Wyoming; 2 sand toads (*Bufo vulgaris*), England; 1 buffalo (*Bison americanus*), ♀ bred in the garden; 1 black ape (*Cynopithecus niger*), Phillipine Islands; 1 moor macaque (*Macacus maurus*), Borneo (?); 2 ashy-black macaques (*Macacus ocreatus*), Celebes (?); 1 African python (*Python sebæ*); 1 Egyptian cobra (*Naia haje*); 1 clapper rail (*Rallus longirostris*), New Jersey; 1 horned lizard (*Phrynosoma douglassi*); 1 rufous rat kangaroo (*Hypsiprymnus rufescens*), and 27 water snakes (*Tropidonotus fasciatus*), born in the garden; 1 rattlesnake (*Crotalus atrox*)?; parasitic jæger gull (*Stercorarius parasiticus*), North Atlantic; 1 great kangaroo (*Macropus giganteus*); 15 banded rattlesnakes (*Crotalus horridus*), and 5 water moccasins (*Ancistrodon piscivorus*), born in the garden; 1 booby gannet (*Sula fiber*), captured off Cape Henlopen; 2 common squirrels (*Sciurus vulgaris*), Europe; 1 orang-utan (*Simia satyrus*), ♀ Borneo; 1 Diana monkey (*Cercopithecus diana*), Africa; 1 saddle-billed stork (*Xenorhynchus senegalensis*), West Africa; 1 tapir (*Tapirus terrestris*) ♀; 4 Yarrell's curassows (*Crax carunculata*); 4 razor-billed curassows (*Mitua tuberosa*); 1 red-breasted swan (*Penelope pileata*), and 18 boas (*Boa constrictor*), South America; 1 eland (*Oreas canna*), Africa, and 2 black wolves (*Canis lupus ater*), received in exchange; 1 hog-nosed snake (*Heterodon simus nasicus*), and 1 rattlesnake (*Crotalus confluentus*) Colorado; 1 soft-shelled turtle (*Aspidonectes*, sp. ?); 1 Javan chevrotain (*Tragulus javanicus*), ♀ bred in the garden; 2 hawks (*Buteo*, sp. ?), Colorado.

— It will appear by the following note from Prof. Birge that we were in error as to the completeness of the series of Bronn's Klassen und Ordnungen.

"Your reviewer has apparently fallen into some errors respecting Bronn's Klassen und Ordnungen. The work is not yet 'drawing to a close.' The Amphibia are the only class of Vertebrates completed; the fishes and reptiles only just begun, while twenty-two parts have only partly finished the osteology of mammals.

"The six parts on birds, treating of osteology and part of the myology, were published nearly ten years ago and none since. Of Crustacea, the first volume is just complete, treating of the Entomostraca only. The worms and insects are not yet begun, while the earlier volumes, especially those on Protozoa and Radiata, are somewhat antiquated.

"The work is indeed invaluable, but no one should buy it in expectation of soon getting the remainder. It has been now twenty years publishing, and at the present rate will not be completed in less than twenty more. Only two volumes, that on Amphibia and the first volume on Arthropoda, have been finished in thirteen years.—*E. A. Birge.*"

— Prof. K. Ellsworth Call and Mr. Arthur F. Gray are now engaged upon a Monograph of North American *Unionidæ*, and desire to make their work complete as regards synonomy. For this purpose they desire shells from all parts of the United States, Mexico and Canada, for purposes of comparison. The shells of the Complanatus group are now desired. Liberal exchanges will be given, or shells (typical) purchased. Parties collecting specimens with soft parts, please address Prof. K. Ellsworth Call, Normal and Scientific School, Dexter, Iowa, or Arthur F. Gray, Danversport, Mass. Information with regard to peculiar forms and interesting localities will be duly acknowledged. Where possible, preserve the animal.

— The *Scientific American* for Dec. 27th, contains an article by D. C. Beard, who accounts for the sea-serpent by supposing it to be the gigantic squid which are known to inhabit the coasts of New Foundland and the high seas. We are not sure but that this is a plausible explanation, and expressed seven or eight years ago, in a communication to the Essex Institute of Salem, that the appearances referred to the "sea serpent" were, perhaps, occasioned by wounded or tired squid of colossal size, such as are known to exist in the oceans in both hemispheres. The barrel-shaped head, large eyes and trailing, undulating body, attributed to the "sea-serpent" can be explained as depicted in the *Scientific American*.—*A. S. Packard, Jr.*

— Second Session of the Chesapeake Zoölogical Laboratory.—A brief report of the work done in this Laboratory has appeared, from which we learn that twelve were present. Dr. Clarke investigated the Hydroids, Prof. Brige the development of two species of crabs, Miss Munn the development of the Ctenophoræ, Mr. Wilson verified the observations of previous writers in regard to the change of Actinotrocha into Phoronis, while Dr. Brooks studied the development of the squid and oyster and ascertained the existence of a rudimentary velum in the Cephalopoda. A brief abstract of his studies on the oyster has already appeared in the columns of the American Journal of Science and arts.—*J. S. K.*

— The report of the curator of the Harvard University Museum of Zoölogy, where geology is also taught, shows that facilities are extended to those desirous of studying lithology. The instruction given by Mr. M. E. Wadsworth during the past year, consisted of lectures upon the macroscopic and microscopic characters of the rocks and their constituent minerals, and also of field and laboratory work. Besides the study of the laboratory collections, each student had assigned to him a separate district, which he was to map, studying the characters and relations of the rocks, and collecting the necessary specimens. Of the rocks thus collected, the student was required to make thin sections and to examine them microscopically, writing a thesis upon the whole work. It was intended that the course should be sufficiently thorough to fit the student for practical field and laboratory research.

— Professor Geikie opened his course of lectures to his class in the University of Edinburgh, November 10th, with a very interesting account of his recent explorations in our Western Territories, a full summary of which appears in *Nature* of November 20th. He described his visit to the Yellowstone park, the Uinta mountains and other portions. His remarks on the evidences of glaciation and the superficial deposits of the West were excellent. He is now preparing an elaborate paper on the glacial phenomena which he observed, which he will offer for publication to some society or journal in this country.

— The committee of the Philadelphia Park Commission, appointed for the purpose, recently held a conference with the committee of the Permanent Exhibition Company. The former, after consideration, resolved to recommend to the commission that the order for the removal of the Permanent Exposition be revoked, on condition that the Permanent Exposition Company raise the sum of $100,000 as a working capital, and agree to conform to the terms of their lease. It is to be hoped that the commission will act on the report of the committee, and give the Permanent Exposition the opportunity to show what it can become.

— Biologia Centrali-Americana. Messrs. Dulau and Co. have commenced a splendid work under the above title, on the animals and plants of Mexico and Central America. It is edited by Messrs. F. D. Godman and Osbert Salvin, who have been collecting their materials for the past twenty-two years. It is to be issued in parts, sixty of zoölogy and twenty of botany, each consisting of about ninety-six pages of letter press, with numerous plates, many colored by hand. The colored plates issued with the first zoölogical part are said to be of remarkable beauty, delicacy and truthfulness to nature.

— Among the names of recently deceased scientists occur the names of Dr. F. Chapuis, the well known Belgian entomologist, who died at Verviers, Sept. 20th; the dipterist C. Rondani, who died at Parma, Sept. 18; and T. Chapman, who died at Burghill, Hereford, Aug. 27. October 17, A. H. Garrod, well known for his papers on the comparative anatomy of birds and mammals, died in London. He was a naturalist of much promise. The death of the French author, Jean Charles Chenu, has lately been reported.

— Prof. J. D. Dana is about to issue a new edition of his very valuable Manual of Geology. This edition will be greatly improved and enlarged and the whole subject brought up abreast of the present progress of the science. This work has occupied the greater portion of his time for several months.

— The Royal Museum of Leiden, as reported by Dr. H. Schlegel, the Director, contains, not reckoning duplicates, 7900 mammals, 50,000 birds, 2920 skeletons, and 4300 skulls. It has one collector in Madagascar and two in West Africa.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

New York Academy of Sciences, Dec. 15.—Mr. Isaac N. Merritt read a description of the remarkable newly-discoved Luray caverns, Page county, Virginia (with illustrative specimens).

Jan. 5.—Prof. H. C Bolton remarked on the application of organic acids to the examination of minerals (second paper).

Boston Society of Natural History, Dec. 17, 1879.—Mr. F. W. Putnam remarked on Conventionalism in Ancient American Art, illustrated by specimens of pottery from the Peabody Museum of American Archæology and Ethnology.

Jan. 7.—Mr. J. S. Diller read a paper on the Felsites and their associated rocks north of Boston. Mr. W. O. Crosby remarked on distorted pebbles in conglomerates, and Mr. F. W. Putnam read a short account of the largest mound in the United States.

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SELECTED ARTICLES IN SCIENTIFIC SERIALS.

American Journal of Science, Jan. 1880.—New forms of fossil Crustaceans from the Upper Devonian rocks of Ohio, by R. P. Whitfield (describes certain Devonian Phyllocarida under the name of *Echinocaris* (new genus), and a Devonian Decapod Crustacean with the name of *Palæopalæmon newberryi*, this being the oldest genuine Decapod Crustacean yet known). New characters of Mosasauroid Reptiles, by O. C. Marsh.

Siebold's und Kölliker's Zeitschrift für wissenschaftliche Zoologie, December 12.—Studies on the organization and development of the Chalinid Sponges, by C. Keller. Structures of the Læmipoda, by G. Haller. On the morphology of the pelvic and shoulder-girdles of the bony fishes, by Olga Metschnikoff. On some octoradiate silicious sponges, and on the development of their buds, by E. Selenka.

Jenaische Zeitschrift für Naturwissenschaft, Nov. 30, 1879.—O. and R. Hertwig continue their beautiful studies on the anatomy and histology of the Actiniæ.

The Geological Magazine, Dec. 1879.—On the Parallel Roads of Glen Roy, by J. R. Dakyns.

Journal of the Queckett Microscopical Club, Nov. 1879.—On a method of resolving diatom tests, by A. Schulze. On the anatomy of Actinia mesembryanthemum, by F. A. Bedwell. On staining sections of animal tissues, by J. W. Groves (a very useful paper). On some improvements in microscopical turntables, by C. S. Rolfe.